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A CONSOLIDATION OF THE CHEMICAL ENGINEER AND CHEMICAL AGE

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CHEMICAL AGE

A CONSOLIDATION of THE CHEMICAL ENGINEER and CHEMICAL AGE

LLOYD LAMBORN, *Editor*

VOLUME 29

NEW YORK, JANUARY, 1921

NUMBER 1

Present Needs of the United States Patent Office

By Robert F. Whitehead

Commissioner of Patents, United States Patent Office

UNDER Article 1 of Section 8 of the Constitution, Congress was granted power to promote the progress of Science and Useful Arts by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries.

Under this power Congress has passed laws authorizing the issuance to any one who has made a new and useful invention in an art, machine, manufacture, or composition of matter of a patent for a term of seventeen years, granting to the patentee the exclusive right to make, use and sell his invention or discovery.

To the Patent Office Congress has given the duty of examining all applications for patent and determining whether the applicant is justly entitled to the patent which he seeks.

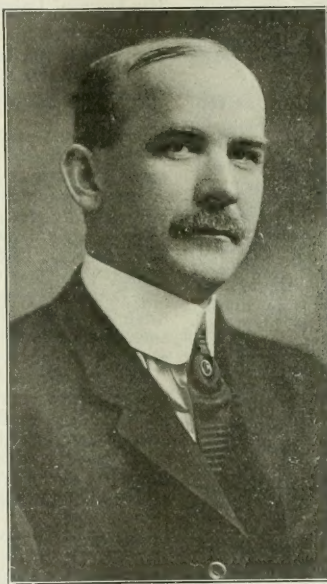
While many people are more or less familiar with patents, few realize to what extent all classes of citizens are affected by the work of the inventor who largely is stimulated to do his work by the hope of a reward from the granting of a patent.

The Patent Office the Cornerstone of Industrial Progress

The Patent Office deals with all the efforts of the world in every field of industry to advance the useful arts. In his report for 1916 the Commissioner of Patents, as illustrating the various interests both public and private which are involved and the extent of such interest, said:

"What great interests are involved, not merely of private but of public concern, may be illustrated by a few examples relating to the field of conservation of fuel.

"The Commonwealth Edison Co. of Chicago reports that it has effected a reduction in coal consumption from nearly 7 pounds per kilowatt-hour to 2.7 pounds per kilowatt-hour within the last 10 years. With this and other economies the cost to the consumer per kilo-



ROBERT F. WHITEHEAD

Commissioner of Patents, United States Patent Office

watt-hour was reduced in 1915 to one-sixth the cost of 1905, and the company in 1912, with a consumption of 1,103,230 tons of coal, produced an amount of electricity which on the basis of the apparatus of 1902 would have required the consumption of 2,650,000 tons.

"The Seventy-fourth Street Station of the Interborough Rapid Transit Co. of New York City has recently introduced improvements which, it is reported, have caused a drop of coal consumption from 2½ pounds per kilowatt-hour to 1½ pounds per kilowatt-hour.

"It is estimated that the new steam plant of the Buffalo General Electric Co. at Tonawanda, N. Y., will generate electricity from coal more cheaply than can be done from the waters of Niagara Falls.

"These great economies are due, in large measure, to the modern automatic stoker and regulator, to furnace construction, to forced draft, to coal-handling machinery, and other inventions.

"What has gone on in this particular field has been going on in almost all of the fields of industry known in 1890 and in many which have been discovered since that date.

"New arts have been discovered such as wireless telegraphy, telephony, and control of torpedoes, searchlights and gun pointing, vacuum cleaning, X-ray apparatus, liquefaction of air to produce oxygen and nitrogen for commercial use, flying machines, the moving picture and mercury-vapor lamps.

"Advances have been made of enormous importance in chemical methods and materials, such as catalytic materials used in the manufacture of sulphuric acid and ammonia, and in the hydrogenation of organic substances; hydrogenation of oils whereby new products are obtained from cottonseed oil; the discovery of cellulose esters; almost innumerable coal-tar products useful in pharmacy, dyeing and photography; gas man-

ufacture, such as acetylene gas; evaporation and drying of milk; gasoline manufacture; fixation of atmospheric nitrogen with resultant production of synthetic ammonia and nitric acid; rapid vulcanizing; glass making; manufacture of synthetic resins; recovery of potash from silicates for the manufacture of fertilizers.

"By way of illustration, I will cite certain facts relating to bread making reported to me by the Mellon Institute. For a period of some five years an industrial fellowship has been maintained there, in which trained scientists have devoted their time to the study of methods of bread making, with the object of producing better bread. Certain of the processes developed have been patented and put into operation on a large scale and it is found that they not only produce better bread, but effect great economies.

"Better nourishment of the yeast has reduced the amount required in raising the bread and maturing the dough, with consequent lessening of the amount of flour and sugar which is used up by the yeast and converted into carbon dioxide and alcohol. The saving of these and other economies to those employing the novel processes are estimated to amount to over \$1,000,000 per annum. This estimate is based upon the present high scale of prices, but on any scale of prices would be enormous.

"The economy is illustrated in another way, as follows: The average flour production for the State of Kansas is about 20,000,000 barrels, or, roughly, 4,000,000,000 pounds. The saving of flour effected is about 2 per cent., which would amount to 80,000,000 pounds, or 400,000 barrels annually on the production of this one State.

"In the field of electrical engineering there has come the electric heater, the electric elevator, the supplanting of cable street railways by electric street railways, the electrification of long steam railway lines, train control, storage-battery developments, polyphase and high voltage systems of electric transmission, electro-dynamic phase transformers, long-distance transmission in telephones, and the development of the automatic switch-board.

"I personally know of two patents, in the electrical field, both about to expire, each of which shortly after it was granted was sold for a large sum. Neither has been the subject of litigation, yet neither could at any time since the purchase have been bought for many times the sum paid for it.

"In the field of farming implements there have come the tractor engines, apparatus for digging irrigation and drainage canals, beet harvesters, corn and cotton planters, deep-soil disk plows, cleaning and manipulation of cotton and wool fiber, and other great advances.

"But what is true of these arts is true of innumerable others, such as spinning, weaving, manufacture of steel, reinforced concrete for bridges and the like, the steel frame building, stone-working machinery, coal-mining machinery, and oil-drilling machinery.

"The automobile has been almost wholly developed since 1890, and there have been vast advances in the construction of internal combustion engines; water purification methods and filters; fire extinguishers; match making, basket and barrel making machines; electrical welding; calcium carbide making; sound reproducing machines; flotation processes of concentrating ores; flour making and refining; shoemaking machinery.

In fact, the list might be extended almost indefinitely; and the prospect is that as great, or greater, advances and discoveries will be made in the immediate future."

Origin of Patent Examination

Prior to 1836 the system both in this country and abroad was to grant patents on application, therefore, without any search to determine whether the alleged invention was really new. The system of granting patents on examination, which was established in 1836, was primarily to safeguard the public interest by the avoidance of unwarrantable grants.

It is obvious that the more thorough the examination and the more accurate the determination of the scope of a given invention, the more valuable the patent is to the patentee and the less likelihood there is of the improper grant of a patent or the grant of one with claims which are too broad. It is also obvious that in order that such an examination may be made it is necessary that the examining corps be composed of men qualified for such work both by education and experience and that they shall have time not only to make examinations but to study and keep abreast of what is being done in their several arts.

The Crux of Patent Office Inefficiency

It takes time for an examiner to learn his art and how to handle it efficiently. An excessive loss of trained men is very uneconomical as new men cannot for a long time efficiently do the work of those whom they replace.

The salaries paid at the present time to the members of the examining corps are not such as to hold the men or to attract properly trained men to stand the entrance examinations. During the year 1919 there were seventy-seven resignations from the examining corps of slightly over four hundred, and during the first ten months of 1920 there were seventy-eight resignations. The Civil Service Commission has not been able for a long time to furnish sufficient eligibles to fill these vacancies and many of the Fourth Assistant Examiner's positions have been filled by making appointments of persons who had not passed the required test.

The greatest need of the Patent Office at the present time is, therefore, such a reorganization of the salaries as will attract graduates of the technical schools and justify them in making this work their life work. In other words, to change the Patent Office from what it largely is at the present time, a mere training school, to an institution offering a real career to its employees.

Laggard Legislative Aid

A bill (H. R. 11,984) for this purpose was passed by the House of Representatives last year and is now in conference, having been passed by the Senate in a somewhat different form. If this bill becomes a law it is believed that the desired results largely will be obtained.

If the examining corps could be stabilized not only would examinations for ascertaining the novelty of inventions be better made, but the work could be kept much more nearly up to date. At the present time, due to the overturn in the examining corps and to a very large increase in the number of applications being filed, the work is far in arrears. In many instances this delay works a hardship on inventors and their assignees.

Completion of Reclassification

Another need of the Patent Office is the completion of the work of reclassification of existing patents. This work was begun some twenty years ago, but from time to time has been slowed down owing to the inability of the force to keep up with the examining work and

also carry on reclassification work. At the present time it is not being pushed as vigorously as it should be for the same reason. With the increased force provided for by the pending bill above referred to this work can be proceeded with more rapidly. When all the patents have been classified the question can then be taken up of the desirability of publishing briefs of the inventions and abridgments such as are published by the British Patent Office.

Room for Expansion Imperative

The Patent Office needs now more room, and that need is becoming greater each year. Not only are some of the examining divisions overcrowded and many of the clerks working under undesirable conditions, but there is not room available for the needed expansion of the public search room, the scientific library, and the storage of the rapidly accumulating records.

This relief will have to come either by the erection of a new building or by allowing the Patent Office to occupy a portion of the building across F street, which

is connected to the Patent Office by a tunnel. Plans had been worked out for transferring certain divisions of the Patent Office to this building, but at the outbreak of the war it was found necessary to assign this space to the War Department and the plans could not be carried out.

Statistics of Growth

The work of the Patent Office has increased immensely in the last two years. While statistics are not usually very interesting it may be well to point out how great the increase in the work has been.

During the year ending June 30, 1919, there were filed 62,755 applications for patents for inventions, while in the year ending June 30, 1920, there were filed 81,948. The total number of applications, including applications for the registration of trade-marks, prints and labels, filed in the former year was 75,657 and in the latter 102,940. The increase in the applications for patent was 30 per cent. and in the applications for the registration of trade-marks 72 per cent.

Good Management in Steam Production and Coal Conservation

By R. C. Denny

Combustion Engineer

NO doubt many plant managers are sick and tired of reading articles on how to save coal, and they can scarcely be blamed. The current engineering press is full of them. Often the articles are full of steam flow meters, carbon dioxide formulae, heat balances, tabulated losses of heat by radiation, and recording temperature charts without end. The cuts of these things and the tabulated figures make a real high-brow looking page.

I've always imagined Mr. Average Plant Manager (who I suspect is not a technical man) saying to himself, as he looked over such articles, "Um-um, yes, I suppose that's all true enough, but what the hell is it all about?" And then he calls in his engineer and says: "Jim, read that and tell me whether we ought to do that way, too." So Jim sits down and makes a stab at understanding it, and finally he says: "Well, sir, I think we're doing very well as we are."

Well, this article isn't that kind of a dog. Of course, you may read here something you already know. In fact, about 98 per cent. of it will be of things that you know very well. But if the other 2 per cent. is news to you, and it probably will be, just read that part twice, and then fit it into your experience. Remember, there isn't a heat unit or a carbon dioxide symbol or a confounded degree of temperature in the whole thing—just horse sense. But let's be moving.

Manufacturers howl at the successive price increases of coal, but they have to pay the bills just the same. Congressional investigations are failures as price decliners. Even Government lawsuits in the Supreme Court seem inadequate to shake loose the railroads from their strangle holds on the mines. Government ownership, while it might bring price relief, is not apparently agreeable to any of us common people. So we still pay the Coal Baron his increment of carefully calculated gain.

Just the same, the case is not entirely hopeless; and the remedy is a pleasant one to take. It requires the co-operation of manufacturing plant managers throughout the country, but there are no dues, and no meetings

are necessary. Action is the only requirement—action commencing as soon as you finish reading this article, and continuing forever. The reason you are going to take this action is because it will benefit your corporate pocket book. That's where the pleasant taste comes in.

Each plant executive must concentrate on his coal problem the same amount and quality of his personal intelligence that he bestows on all other departments of his plant. The result will simply be a coal saving, and the combined result will be enough of a letup in the coal demand to give friend Coal Baron another thought or two. But you don't have to think of, or plan for, that combined result. All you have to do is to tackle your own individual job. That's all you can do. Here are some of the things you already know:

Coal is a common raw material, although not a cheap one. It does not appear in your finished product as carbon, however, but it is the first link in a process chain. These processes are simple enough. Coal, burned under steam boilers, gives up heat, which is held and transported by the steam to wherever heat is required in process work, or to steam machinery, where it is converted into electricity or other forms of power, and the power is put into manufacturing processes.

The apparatus for burning coal, generating steam and for generating and transporting and using electric power, is all fairly well standardized, advertised and understood. It is not difficult to hire men to operate this modern apparatus. All this is the outfit for handling the heat ingredient of your plant output. Most of the apparatus is the result of engineering experience; most of it was selected and installed by engineers for you; and it is operated by individuals of the same ilk. But in spite of all that, in the average plant (which very likely is yours) there are continual wastes of this heat ingredient that are so enormous as to be positively criminal.

There is only one answer—carelessness. In any going business there is only one man who is ultimately responsible for continual waste—the manager. Don't fool yourself that your plant is not in this class, Mr. Reader. Your better judgment will rather prompt you

to say: "All right, I'll admit it, at least for the sake of argument. What next?"

There must be a fairly general reason to account for a condition that is recognized among engineers as so very common. The reason is simply that the manager is usually a process man, skilled, of course, in the processes for producing a certain product, and unskilled in the heat game. Even at that, such a reason is a poor excuse. Especially is it a poor excuse when you realize that to catch and can the heat losses requires mostly plain intelligence and executive ability rather than engineering skill. The whole crux of the matter is that coal-saving and elimination of heat losses require only the same sort of organization and supervision as do all other departments.

Executives who manage their plants (not merely let them run) must have daily records of performance. They compare these records with other days and with the output records of manufactured product. To work this out in the coal and steam departments is to manage this department; and it is ridiculously easy—for the executive.

Your plant consumes so many tons of coal daily. How many tons? Measure it. Never mind the details of that. Get reliable engineering advice—but see that you do actually get it. It is one of your two absolutely vital daily figures in this department. But do not check this coal per day with your output per day. There is not a definite relationship, because there is at least one important intermediate process step that essentially modifies it. Leave that for the moment, and take up the next point.

You produce steam, in consequence of burning coal. How much steam? Measure that too. Again, never mind the details; it is perfectly simple, but it is also absolutely necessary. This steam that you measure daily is used throughout your plant. One set of men make this steam, but another set of men use it. With these two records, faithfully and accurately kept, and inspected by you, you have absolute control over this heat ingredient of your plant, as you will see.

A daily comparison of the coal burned and the steam produced is a complete summary of the operation of your boiler plant. You do not need to know anything more; the rest is up to your engineers. Your job is to demand no diminution in the ratio of these vital figures; rather to incite your men to increase the ratio. You need not waste a minute over efficiencies or carbon losses or all the rest of the boiler-room patter. And you can depend upon it, your engineers will do the right things with their coal and their equipment, if you sit on the lid with that steam production ratio. Furthermore, when somebody comes along with a scheme to save you money in your steam production department, you will have accurate dope to check up on.

The quantity of the steam produced daily is the figure that should be compared with your daily plant production records. The relation here should be fairly constant. Increases and decreases in this ratio have definite causes. Again, your job is to insist on the maintenance of proved performance; the details are for your operating force to attend to.

There are many refinements to this simple outline. For instance, there are large plants which have at least one hundred meters measuring steam uses in as many different departments or sections. Again, there are plants where many details of boiler operation are checked daily and very carefully by various instruments. But the rule is a common sense rule. To govern, you must know what is going on. Guess work is no substitute at all—anybody can guess. It surely is beyond

argument that the items which an executive must know are the summarizing items that measure accurately the economy of operation of each responsible department.

It is now not hard to visualize wastes flowing naturally from lack of system and lack of responsibility. Without definite check figures the executive cannot affirm, especially in the face of engineering argument, exactly where heat, which is money, is being seriously wasted. He has nothing to pin to, nothing to measure with. He can hammer all along the line, but the force of his blows is lost through lack of proof with which to confront the men who know as much about it as he does. It seems quite clear, on the other hand, that the departments which use steam are the ones to be held responsible for the quantity consumed, not the department which makes it. This is perfectly simple and perfectly rational, but it is also perfectly well ignored in most plants, where the executive storms at everybody because he is all balled-up trying to locate the wastes.

Consulting engineering services may be necessary or advisable in starting off a program such as is herein advised. But the common, garden variety of plant engineer knows a good deal about these matters, too. After all it is a matter of judgment. There must be active cooperation between the executive and his engineer, and it must be perpetual. There is too little of this. Because they speak different technical languages is no reason for lack of team work. The biggest item of engineering is common sense. Authority and skill, working shoulder to shoulder, with accurate records can revolutionize plant conditions.

When the plant problem is on a large scale, carbonization of coal becomes a factor seriously to consider. Bituminous coal, especially, will yield a host of valuable by-products if subjected to low-temperature distillation, and the residue is coke that is of prime value as a heat generator. The fluctuation of prices for these by-products render any general calculations of little value in a published paper. But a manufacturing proposition, taking into consideration past, present, and probable future by-product prices can be rationally considered by the engineering and managing heads of any business whose power problem looms large.

Now return to where we started. Coal saving can be effected, of course, by engineers concentrating their attention on boiler-plant operation. The point here brought out is the infinitely more general proposition that coal-saving not only can be, but must be, effected on any large scale, by the direct action of plant executives themselves. Try the method described. You can't lose. If you fizzle it's time you ordered your coffin. But you won't; you'll get just exactly the grip on this hitherto elusive heat production game that you have always wanted. And you will not only put your heat plant on an economical basis, but you will keep it there—which means you will save a lot of coal. That, in turn, when done by a multitude of plant managers, will swat the Coal Baron the most effective blow in his tender spot—the retail price of coal.

The Cotton Mfg. Co. will establish a plant at Montgomery, Ala., initial cost \$100,000, to manufacture paper from linters and waste cotton, with a daily capacity of 200 bales of linters. Expansion in the utilization of waste cotton fibre for paper is encouraged by the demand for paper and the conditions in the wood pulp industry. The establishment of this industry in the South represents not only the local more intensive utilization of its main crop but the transfusion of manufacturing activity into agricultural regions.

The American Coal-Tar Chemical Industry in 1919

THE results of a canvass of the production activity of 214 manufacturers, embracing every producer of dyes and coal tar chemicals in America during the calendar year 1919 has been received from the United States Tariff Commission.

The appearance of this report* coincident with the consideration by the Congress of the Longworth Bill, which would impose reasonable restrictions upon the import of foreign dyes which in quantity and quality may not as yet be available from the stocks of domestic manufacturers, and the passage by the British Parliament of a Licensing Bill effecting a similar measure of protection to British dye producers against the unscrupulous competition of a more advanced foreign industry, a copy of which will accompany this text, provides the necessary information from an impartial and creditable source and the precedent of an example for similar legislation in behalf of American enterprise in a field intimately related, as is no other form of industrial endeavor, with American destiny.

Crudes

One of the outstanding developments during 1919 which is of significance in considering the future of the coal-tar chemical industry is the increase of 17.2 per cent. in the productive capacity of by-product coke ovens in the United States. The production of coke in by-product ovens was 56.2 per cent. of the total production, and thus for the first time exceeded the output of the wasteful beehive ovens.

The following table shows the percentage of the United States output of coke produced in by-product ovens, as compiled by the Geological Survey:

1890	0
1900	5.3
1905	10.7
1910	17.1
1915	33.8
1916	35.0
1917	38.6
1918	46.0
1919	56.2

There is no question that, with the possible exception of anthracene, adequate supplies of fundamental raw material are now available from domestic sources for the future growth and expansion of the coal-tar chemical industry in the United States. In 1919 considerable progress was made as to supplies of anthracene, the output of this important material being about three times the production of 1918. Moreover, a large

proportion of it was refined. Although this shows encouraging progress, a much greater increase in output must be secured before there will be a sufficient supply of anthracene for alizarin and vat dyes.

It may be roughly estimated that the 1919 production contained about one-fifth the amount of pure anthracene required for American needs. The difficulty in securing adequate supplies of anthracene is the most important and fundamental problem awaiting solution in the dye industry. When a sufficient supply of anthracene is secured an adequate production of alizarin and vat dyes will soon follow.

The fundamental difficulty is not primarily an actual lack of anthracene in the tar, nor are there purely technical difficulties in its recovery, but rather the fact that its removal leaves the pitch so hard that it does not find a ready market in this country. Any method of recovering anthracene which seriously disturbs the marketing of the other larger fractions of the tar, especially the pitch, would make the anthracene so expensive that the dyes derived therefrom could not be made on a competitive basis. In England and Germany large amounts of hard pitch were used for the briquetting of coal dust and coke breeze, but this industry is little developed in the United States. England shipped considerable amounts of crude anthracene to Germany before the war.

Whether the problem will be solved by the tar distillers or by the development of a synthetic process for making anthraquinone (the most important intermediate made from anthracene) from raw materials now available in adequate quantity can not be determined at the present time. Active work along both lines is well under way and important progress has been made during 1920.

Intermediates

As appears from the accompanying table the total production of intermediates decreased from 357,662,251 pounds in 1918 to 177,362,426 pounds in 1919. This falling off was due to decreases in the output of certain intermediates which were used during 1918 in the manufacture of explosives and poison gases, or which were made during 1918 with the expectation of future military demands.

The signing of the armistice left on hand large stocks of these intermediates and during 1919 they were diverted to the manufacture of dyes or other fin-

A BILL TO

Regulate the importation of dyestuffs

BE it enacted by the King's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled and by the authority of the same, as follows:

1. (1) With a view to the safeguarding of the dye-making industry, the importation into the United Kingdom of the following goods, that is to say, all synthetic organic dyestuffs, colours and colouring matters, and all organic intermediate products used in the manufacture of any such dyestuffs, colours or colouring matters shall be prohibited.

(2) Goods prohibited to be imported by virtue of this Act shall be deemed to be included among the goods enumerated and described in the Table of Prohibitions and Restrictions hereinafter contained in section forty-two of the Customs Consolidation Act, 1876, and the provisions of that Act and of any Act amending or extending that Act shall apply accordingly.

2. (1) The Board of Trade have power by licence to authorize, either generally or in any particular case, the importation of any of the goods, or any class or description of the goods prohibited to be imported by virtue of this Act.

(2) For the purpose of advising them with respect to the granting of licences the Board shall constitute a committee consisting of five persons concerned in the trades in which goods of the class prohibited to be imported by this Act are used, three persons concerned in the manufacture of such goods, and three other persons not directly concerned as aforesaid.

Such one of the three last-mentioned persons as the Board shall appoint shall be chairman of the committee.

(3) For the purpose of providing for the expenses incurred by the Board in carrying this Act into execution, the Board may charge in respect of a licence a fee not exceeding five pounds.

3. Subject to compliance with such conditions as to security for the re-exportation of the goods as the Commissioners of Customs and Excise may impose, this Act shall not apply to goods imported for exportation after transit through the United Kingdom or by way of transhipment.

4. Anything authorised under this Act to be done by the Board of Trade may be done by the President or a Secretary or Assistant Secretary of the Board or by any person authorised in that behalf by the President of the Board.

5. (1) The provisions of this Act shall continue in force for a period of ten years from the commencement thereof and no longer.

(2) This Act may be cited as the Dyestuffs Import (Regulation) Act 1920.

*The British Dyestuffs Act, Effective
January 15, 1921.*

*Tariff Information Series No. 22: Census of Dyes and Coal-Tar Chemicals, 1919.

ished products. The most conspicuous example of this kind is phenol, made almost entirely in synthetic phenol plants, which decreased from 106,794,277 pounds in 1918 to about 1,543,659 pounds in 1919. At the signing of the armistice about 35,000,000 pounds of phenol, nearly three times the normal annual consumption, were on hand awaiting conversion into explosives, for the sale of which the Monsanto Chemical Co., St. Louis, Mo., was made the agent of the War Department.

The synthetic phenol plants responsible for the huge output shut down promptly after the signing of the armistice, and many of them were later entirely dismantled. It is probable, however, that the present and future consumption of phenol will be in excess of the output of natural phenol obtained by separation from coal-tar distillates, and that when the surplus stocks have been consumed some of the synthetic plants will necessarily resume production.

Other intermediates used both for war purposes and for dye manufacture which showed a striking decrease in 1919 include monochlorobenzene, with a decrease of 80 per cent.; nitronaphthalene, 36 per cent.; dimethylaniline, 16.5 per cent.; diphenylamine, and dinitrotoluene. It is probable that the production of all of these in 1919 was below the amount used during the year for dye making, and that stocks on hand November 11, 1918, and intended for military uses were diverted to the dye industry. It may therefore be assumed that the production of these intermediates during 1919 was somewhat less than actual requirements.

Intermediates required in the manufacture of dyes used for military uniforms also showed a decrease corresponding to the decreased output of such dyes. Among these may be mentioned: m-dinitrobenzene and m-nitraniline which are used in Alizarin Yellow GG and R—dyes used on wool cloths for army uniforms—and m-tolylendiamine, used for sulphur browns on cotton cloths for khaki uniforms.

Intermediates Consumed in Large Quantity

As a rule the intermediates for which there is the largest normal consumption and the manufacture of which had been well established by 1918, showed comparatively little change during 1919. Examples of these are nitrobenzene, aniline, paranitraniline, and betanaphthol. On the other hand, there are also many examples of a large increase in the production of intermediates difficult to make but which are required for dyes of the best quality.

A good example of this kind is amidonaphthol sulphonic acid 2:8:6 (gamma acid). This was made in 1918 by a single firm, but in 1919 by five firms, with a combined output of 155,025 pounds, valued at \$667,360, which is many times the 1918 output. These five firms

used gamma acid to make nearly a half million pounds of Oxamine Black—an important direct black which can be developed on the fiber. Moreover, gamma acid is also required for other important direct cotton dyes of a fast type, and in the manufacture of Zambesi Black, a very important dye for union hosiery.

Toluene Derivatives

There was a notable increase in output and a marked decrease in price of those intermediates derived from toluene. Benzoic acid, U. S. P., for example, increased in output from 172,896 pounds in 1918 to 699,108 pounds in 1919, and the price dropped from \$3.07 to \$0.77 per pound. Orthotoluidine and paratoluidine, important intermediates doubled in output, with about a 50 per cent. reduction in value. The general increase in output of toluene derivatives and the decrease in value are due to removal of war-time restrictions on toluene and the lessened demand for it.

Intermediates Derived from Anthracene

During 1919 the actual anthracene content of the anthracene produced amounted to 813,318 pounds, or over three times the output in 1918. In 1919 three firms, as against only one firm in 1918, reported a production of refined anthracene of more than 80 per cent. purity suitable for the manufacture of vat and alizarin dyes. The total quantity of refined anthracene produced was several times the output of the previous year. It may be roughly estimated that over 4,000,000 pounds of pure anthracene would be required to manufacture alizarin and vat dyes to the amount of the average annual import from 1912 to 1914, inclusive.

The progress among the anthracene derivatives is of especial interest. Here, unfortunately, definite figures can not be given without revealing the production of individual firms. In 1919 there were ten intermediates produced from anthracene, as against only five in 1918. The output of anthraquinone, which is the most important because it serves as the raw material for the manufacture of nearly all other intermediates derived from anthracene, was about ten times as great in 1919 as in 1918.

Recent information indicates that several firms are experimenting on the production of anthraquinone synthetically from benzene and phthalic anhydride. One firm is now (December, 1920) known to be manufacturing synthetic anthraquinone in commercial quantities. The production of anthraquinone in adequate quantity either from natural anthracene or synthetically from other coal-tar materials already available will mean much to the future development of a well-rounded and permanent dye industry in the United States.

Summary of the production of coal-tar chemicals, 1918 and 1919

	1918			1919		
	Number of manufacturers	Quantity	Value	Number of manufacturers	Quantity	Value
		Pounds.			Pounds.	
Group I.—Crudes ¹	35		\$22,474,075	24		\$17,657,750
Group II.—Intermediates.....	128	357,662,251	124,382,892	116	177,362,426	63,210,079
Group III.—Finished products.....		76,902,959	63,815,746	155	82,532,390	64,365,544
Dyes.....						
Dutiable at 30 per cent plus 5 cents per pound.....		53,825,677	58,255,391		52,310,482	59,950,522
Dutiable at 30 per cent.....		4,638,769	3,770,991		11,091,712	7,648,333
Total of dyes.....	78	58,464,446	62,026,390	90	63,402,194	67,598,855
Color lakes, dutiable at 30 per cent plus 5 cents per pound.....	29	9,590,537	5,020,023	34	7,569,921	4,179,964
Photographic chemicals, dutiable at 30 per cent plus 5 cents per pound.....	6	316,749	823,915	10	335,509	1,059,340
Medicinals, dutiable at 30 per cent.....	31	3,623,352	7,792,964	31	6,777,988	7,883,071
Flavors, dutiable at 30 per cent.....	7	456,258	4,825,627	9	610,525	1,318,654
Synthetic phenolic resins, dutiable at 30 per cent plus 5 cents per pound.....	5	4,233,356	2,042,120	5	3,794,534	2,381,358
Tanning materials (synthetic).....	1			1		
Perfume materials.....	6	116,263	564,695	6	41,419	164,302

¹ Production of coal-tar distillers does not include production of crudes at by-product coke ovens, which was reported to United States Geological Survey

Intermediates Used in Dyeing and Printing

In many cases the last chemical step in the manufacture of dyes can be advantageously performed on or within the fiber to be dyed rather than in a dye factory. In this way an insoluble dye can be precipitated within the fiber, and thus secure a high degree of fastness. As a consequence, textile mills and other dye consumers have been purchasers of intermediates.

The German dye makers made a practice of selling intermediates for this purpose to textile mills under special trade names designed to conceal the chemical nature of the product. German firms were thus enabled in many cases to charge prices to the consumers above the market prices of the intermediates when sold under their true chemical names.

The translation of these trade names into their scientific chemical equivalents will enable American consumers to purchase these materials under their own proper names at more reasonable prices, and will also help American intermediate makers to supply those not yet made in the United States.

Dyes

During 1919 the total output of dyes was 63,402,194 pounds, valued at \$67,598,855, an increase of about 8 per cent. in quantity as compared with 1918. The production in 1919 exceeded by 38 per cent. in quantity the imports during the fiscal year 1914. The increase in total output by no means measures the whole improvement in the situation.

An analysis of the figures for 1919 shows many instances of substantial decrease in those dyes which are relatively easy to make and also of those needed in large amounts during 1918 for Army and Navy uniforms. Decreased output of these particular dyes has been more than offset by the increased output of dyes of better quality, many of which were made for the first time in the United States during 1919.

The domestic industry has been especially successful in the production of those colors for which there exists a large and constant demand. Sulphur black, which is consumed in the United States in larger amounts than any other color, was produced to the extent of 14,504,770 pounds by thirteen manufacturers.

Some of the American brands are superior in quality to the best products imported from Germany before the war. Another notable achievement was the production during 1919 of indigo in amounts exceeding our prewar import. This dye, which ranks second in consumption by the United States, ranks first in world consumption on account of its large use in China.

In its war-time development, particularly in 1915 and 1916, the new American dye industry naturally sought the line of least resistance by making the dyes which were easiest to make, and the consumers used whatever dyes they could get instead of the varieties they preferred. As a result there were many cases of enforced substitutions of both German dyes (available from stocks) and American dyes. This substitution in early years of the war materially damaged the reputation of American dyes. During the succeeding years there has been a steady and progressive improvement in the situation.

Although consumers were better supplied with the particular dyes they desired in 1919 than they were in 1918, there were still needed certain types of dyes which could not be supplied from American sources in the quantity desired. Thus in 1919 there was an insufficient domestic output of vat dyes which, on account of their extreme fastness and beauty of shade, are important for cotton shirtings, gingham and

calicos. Considerable progress has been made, however, toward supplying these much-needed colors. There is also a demand for many individual dyes of other classes which are not yet available at all or only in inadequate amounts. This is particularly true of alizarin derivatives and of certain other specialties.

Diversity of Products of Coal-Tar Chemistry

The finished products of the coal-tar chemical industry include (1) dyes, (2) color lakes, (3) photographic chemicals (developers), (4) medicinals, (5) flavors, (6) perfume materials, (7) synthetic phenolic resins, (8) synthetic tanning materials, and (9) explosives. There are many other substances belonging to all of these classes (except the synthetic resins and synthetic tanning materials) that are not derived from coal tar and that do not need to be considered for the present purpose.

A few minor uses of coal-tar products hardly deserve separate classification for the present purpose. For example, sodium benzoate and sodium salicylate are used as food preservatives as well as for strictly medicinals purposes, but these uses are so closely allied that it does not seem proper to set up a separate class of food preservatives. Many dyes and lakes are used as inks or ink powders, either pure or mixed with gum or other vehicle. A separate classification would therefore result in the overlapping of the two classes of products.

Some coal-tar chemicals, usually and properly classified as intermediates, are used for accelerating the vulcanization of rubber, the most important being aniline, thiocarbaniide, phenylenediamine, and nitrosodimethylaniline. As the substances used for this purpose belong to the class of intermediates and are so classified in the tariff law, it seems inadvisable to set up another class of finished products.

The technical and generic relationship of these different classes is exceedingly close. To a large extent they use the same intermediates. Phenol enters into the manufacture of some representatives of each of the nine classes of finished products. Aniline is used for making dyes, lakes, medicinals, photographic chemicals, and explosives. Numerous other examples showing this close relationship could be cited.

The close relation of dyes to explosives and poison gases and the ease with which a dye factory can be converted into an explosive or poison-gas plant in an emergency, have been exemplified since the signing of the armistice by the conversion of certain plants in the United States which were erected for the manufacture of explosives into plants for the manufacture of intermediates and dyes.

A close relation also exists between the dye industry and the manufacture of flavors, perfume materials, photographic chemicals, and color lakes. A well-rounded and matured dye industry would inevitably be accompanied by these smaller offshoots, which in many cases would furnish an outlet for by-products obtained in making the intermediates needed for the dye industry. The synthetic phenolic resin industry and the synthetic tanning material industry are not so closely related to the dye industry as are the other cases cited. They are dependent chiefly upon phenol and formaldehyde, and therefore furnish an outlet in times of peace for the material, phenol, which is of such vital military importance.

Color Lakes

The coal-tar products included in this group are a class of pigments used for paints, lithographic inks,

and many other purposes. They are made by "fixing" a coal-tar dye on an inert base material, such as aluminum hydroxide, or barium sulphate (blanc fixe).

The total output of coal-tar color lakes in 1919 was 7,569,921 pounds, or a decrease of 25 per cent. from 1918. Red lakes were first with an output of 3,151,149 pounds, or 42 per cent. of total lakes. Of this quantity about 17.9 per cent. was Lithol Red and 15.3 per cent. Para Reds. The other important lakes in order of production in 1919 were scarlet, maroon, yellow, blue, eosine, green, violet, and orange.

Photographic Chemicals

The total output of coal-tar products used as developers in photography increased from 316,749 pounds in 1918 to 335,509 pounds in 1919. Hydroquinone, the most important product in this group, decreased 11 per cent. in output to 272,329 pounds. Methyl p-amidophenol sulphate (metol), another important photographic developer, showed more than a 400 per cent. increase in production in 1919, as against that of 1918, due to exceptional enterprise.

Medicinals

The production of coal-tar medicinals in 1919, exclusive of deducting 2,103,101 pounds of disinfectants—a product not reported in 1918—showed an increase of 1,051,535 pounds, or 29 per cent. more than the 1918 production. The total output, including the disinfectants, was 6,777,988 pounds, valued at \$7,883,071.

Acetylsalicylic acid (aspirin) in 1919 accounted for over one-half of the total value of medicinals, the quantity produced being 1,777,105 pounds, or nearly double the 1918 output.

A large increase was reported in the production of acetphenetidine, chloramine T, phenolphthalein, neosarphenamine, b-naphthol benzoate, guaiacol crystals U. S. P., and guaiacol liquid; while the following products showed a decrease in output: Arsphenamine, bismuth b-naphthol, bismuth tribromophenol, dichloramine T, phenolsulphophthalein and phenolsulphonates.

The following are among the medicinals which were reported in 1919 for the first time: Anesthesine (ethyl p-amino benzoate), cinchophen (phenylcinchoninic acid), dibromoxy-mercury fluorescin, copper sulphocarbonate, sodium sulphocarbonate, zinc sulphocarbonate, cresote carbonate, guaiacol carbonate, b-naphthol salicylate, amyl salicylate, and ammonium salicylate. The progress made during 1919 in the production of a greater variety of coal-tar medicinals is an important addition to the American coal-tar industry.

Flavors and Perfume Materials

Further progress was made during 1919 in the manufacture of flavors and perfume materials derived from coal tar. There is no sharp difference between these products, many of them being suitable for both flavors and perfumes. One of them, here considered as a

flavor, is the substance saccharin, which in recent years because of the scarcity and high price of sugar, has had extensive use as a sugar substitute, and also as a sweetener in chewing tobacco. The output of saccharin was 547,988 pounds, valued at \$1,017,091, or an increase of nearly 29 per cent. over 1918. This increase was made possible through the release from military control of toluene, the raw material. The average price of saccharin decreased to \$1.86 per pound as compared with \$10.55 in 1918.

Coumarin, used both as a flavor and as a perfume in scented soaps, has more than doubled in output from 1917 to 1919. Synthetic coumarin has practically replaced the natural product derived from tonka beans.

Benzyl benzoate and benzyl acetate, ordinarily considered as perfume materials, were used in large quantities as solvents in the manufacture of varnish for aeroplane wings. Recently benzyl benzoate has been used with considerable success as a non-narcotic antispasmodic. The output of both products decreased in 1919.

The output of benzyl benzoate in 1919 was less than one-twelfth the 1918 production, while benzyl acetate decreased nearly 50 per cent. Perfume materials whose output increased in quantity during 1919 include: Bromstyrol, cinnamic alcohol, methyl acetophenone, methyl anthranilate, and methyl phenylacetate. Several perfume chemicals were reported in 1919 for the first time.

Synthetic Resins

Although the total 1919 output of synthetic resins was about the same as in 1918, the production of individual resins differed widely. Those resins, derived from phenol by condensation with formaldehyde and hexamethylenetetramine increased in quantity as compared with the 1918 figures. As a direct effect of this increase there was a decrease in output of resins obtained from cresol, a substitute for phenol during the war. Resins made by condensation of solvent naphtha paracoumarone showed an increased output in 1919. The synthetic phenolic resin industry, the products of which have many different uses, was created by inventions of American chemists. The development in the last few years has been achieved by laborious and painstaking research conducted with an intimate knowledge of the requirements in other industries in which these products are now used.

Synthetic Tanning Materials

Synthetic tanning materials are of comparatively recent origin, having come into commercial use in Germany and England since 1912. They are made by the condensation of certain coal-tar derivatives and formaldehyde in the presence of an acid. They have proved their value for tanning, but they are sometimes sold in combination with a small amount of natural tanning extract. Their use results in (1) great economy of time required for tanning; (2) a satis-

Classification of Dyes According to Method of Application on the Fibre, and Comparison of 1914 Imports with Production for 1917, 1918 and 1919.

Class	1914		1917		1918		1919	
	Imports.	Per cent of total.	United States production.	Per cent of total.	United States production.	Per cent of total.	United States production.	Per cent of total.
Direct.	Pounds, 10,264,277	22.34	Pounds, 11,181,761	21.32	Pounds, 12,284,063	21.01	Pounds, 14,444,834	22.78
Vat (including indirect.)	10,352,662	22.38	280,746	.63	3,284,337	5.61	9,352,992	14.59
(a) Indigo	8,497,359	.....	274,771	.....	3,083,888	.....	8,863,824	.....
(b) Other vats.	1,855,304	.....	14,355	.....	127,419	.....	389,158	.....
Acid....	9,286,561	20.21	9,372,121	20.38	9,799,071	16.76	12,185,968	19.24
Sulphur....	7,082,970	15.35	15,588,222	33.91	23,668,878	40.81	17,624,418	27.54
Morant....	1,359,412	9.63	4,164,362	9.65	5,417,192	9.32	3,985,050	6.29
Basic....	3,002,489	6.33	2,019,043	4.52	2,879,639	4.92	4,086,332	6.37
Dyes for color lakes and spirit sol. dyes.	1,312,665	3.29	624,360	2.03	1,068,465	1.83	1,813,190	2.86
Unclassified.....	27,000	.06	2,368,541	5.15	4,233	.01	49,111	.07
Total.....	45,990,865	100.00	45,977,546	100.00	58,464,416	100.00	63,402,194	100.00

factory leather of light color, and (3) a reduction in the quantity of natural tanning extracts required. As the supply of domestic natural tanning materials is decreasing, the domestic tanning industry is becoming more and more dependent upon natural tanning ma-

terials of foreign origin. These synthetic products, therefore, promise to be of great importance in the future of the domestic industry. A single firm in this country reported the manufacture of these materials in 1919.

A Massachusetts Tech. Man Appointed Executive Head of the Guaranty Trust Co. of New York

The elevation of a student of applied science in the special field of mining engineering and metallurgy to the chairmanship of the board of directors of the Guaranty Trust Co. of New York, as the culmination of the practical experience of the brief span of 23 years, is a stimulating commentary on the potentialities and versatility of the technically educated man.

William C. Potter was born in Chicago on October 16, 1874, and graduated from the Massachusetts Institute of Technology in 1897 with a degree of Bachelor of Science in Mining Engineering. From that time on he followed his profession in New Mexico, Colorado and Montana until he became general manager of the Guggenheim Exploration Company in Mexico and later general manager of the American Smelting & Refining Company for Mexico and the Southwest. In 1911 he became president of the Intercontinental Rubber Company and on July 8, 1912, was elected a vice-president of the Guaranty Trust Company and continued there until March 15, 1916, when he resigned to become a member of the firm of Guggenheim Brothers. He continued as a director of the Guaranty Trust Company and member of its Executive Committee.

During the year 1918 Mr. Potter was called to Washington and was appointed Chief of the Equipment Division of the Aviation Corps of the U. S. Army. For his services he was awarded the Distinguished Service Medal and was recently decorated by the Italian Government as a Commander of the Order of the Crown.

In addition to membership in the firm of Guggenheim Brothers, Mr. Potter is chairman of the Board of the Kennecott Copper Company, president of the Braden Copper Company and vice-president of the Chile Exploration Company, and on the Finance Committee of the Utah Copper and Nevada Consolidated Copper Companies, besides being a director in a number of other mining, steamship and industrial companies.

One of the enduring compensations of a teacher's work is the merited recognition of the ability of boys that he has had an opportunity to influence and form. In the body of Tech men all over the world there is no greater pride in this notable recognition of a Technology man than resides in the satisfaction of Prof. Richards that Potter is one of his boys.

Grasselli Chemical Company is planning the erection of a plant in Long Island City, New York.

H. Foster Bain Succeeds Frederick G. Cottrell as Director of the Bureau of Mines

With the end of 1920 Dr. Frederick G. Cottrell, who succeeded Dr. Van H. Manning as Director on June 1, last, terminated ten years' service with the Bureau of Mines in the successive positions of chief physical chemist, chief chemist, chief metallurgist, assistant director and director. Dr. Cottrell will succeed Prof. W. D. Bancroft in the chairmanship of the Division of Chemistry and Chemical Technology of the National Research Council.

The new director of the Bureau of Mines is H. Foster Bain of California who was educated and trained as a geologist and mining engineer. Mr. Bain was born at Seymour, Indiana. Graduating from Moore's Hill College, Indiana, in 1890, he spent two years at Johns Hopkins University and later received his doctor's degree from the University of Chicago. He was one of Herbert Hoover's assistants in London on the Belgian relief work during the war. Before that he was editor of the Mining and Scientific Press of San Francisco, Calif., and later the editor of the Mining Magazine of London, England.

He made some important mining investigations in south and central Africa and later undertook similar investigations in China. At one time he was a mine operator in Colorado and once was connected with the United States Geological Survey. Subsequently, he was the first director of the Geological Survey of Illinois.

For a time during the war Mr. Bain was assistant director of the Bureau of Mines, following up production and manufacture of

metal products, explosives, and other chemical substances for war purposes.

In answer to many inquiries the Procter & Gamble Co. issues the following statement explanatory of its reaction to the prevailing period of deflation: "Readjustment of the company's raw materials from war prices to pre-war basis has been practically completed. The company has written down inventories to the present market prices making proper provision for loss due to shrinkage in values and it confidently expects to go forward upon a normal basis of production. Sales management is confident that the change in the company's selling policy will prove greatly to its advantage and that its earning power, upon resumption of normal buying throughout the country, will be greater than ever before. It is the expectation of the management that dividends upon stock will be continued at the present rates."



WILLIAM C. POTTER
Chairman, Board of Directors, Guaranty
Trust Co., of New York

The Marsh Electrolytic Cell for Chlorine and Caustic Soda

By Clarence W. Marsh

Chemical Engineer

NOT many years ago even cheap power required its salesmen. We were invited to take advantage of this very important factor for electrochemical enterprises. Suddenly, with the advent of the great war, cheap power disappeared. Today there is no such thing as cheap power within reasonable distance of zones of industrial activity. Public service corporations have been authorized to increase power rates. Hydroelectric power in many cases costs double prewar rates. We all know what has happened to steam-generated power. Coal is a gem. Oil is in the same class.

The electrolytic chlorine and caustic soda industry has felt the burden severely. Even with cheap power, this item of cost loomed as a large if not the largest factor of cost. But other items became causes for serious concern. Prices of raw materials and cost of labor increased steadily. Then it was discovered that power was the important factor, not because of the cost of the power, but on account of the destruction it caused. Every bit of power that was wasted and not employed directly in production caused added expense in every other item. Because of this high cost of raw materials and cells, it was discovered that no matter how cheap the power, no concern could afford to remain content with low energy efficiency.

Now comes the problem. Electrolytic cells, equipment and buildings are more expensive to construct than ever before. Heretofore manufacturers believed that it was a mere case of spending money to get high efficiency and conserve power by constructing more cells and operating them at lower current densities.

Engineers figured that the expense was not warranted by the power saved. But here they stopped. The losses due to the power wasted in the heat and electrical resistance within the cells were not analyzed very closely. High prices uncovered losses which the engineer passed over. The business man is now aware that power must be conserved, not only for its own sake, but for the sake of the other items of expense. Electrolytic cells of high energy efficiency must be had.

High efficiency is another name for economy and invariably brings in its train many other advantages. Today the average electrolytic cell plant uses approximately 40 per cent. of the power in useful work. The very best cells use, on an average, less than 50 per cent. of the power in useful work and waste more than 50 per cent. In electrical engineering practice this is a very poor showing. In the past it has required large expenditures for buildings and for cells to make it possible to use even 50 per cent. of the power in useful work.

Description of the Marsh Electrolytic Cell

This cell has been developed to meet these changed conditions and the demand for an electrolytic cell of the highest energy efficiency, viz., 60 per cent. to 70 per cent. It is a natural consequence that in creating this improvement in electrolytic cell engineering many other conditions have been bettered by conforming to the fundamental principles of good electrochemical practice.

The cells are one-half as large or less for the same output as those now in use. The amount of material used in construction has been greatly decreased. The floor space required is less than one-half. Furthermore, the constructional features make it possible to change the methods of handling. Operating floor space required is from one-third to one-fifth of the present practice.

Anodes are made of graphite; the cathodes, of perforated sheet steel. The surfaces of the electrodes must be opposite and near each other, using the least weight of material in the smallest space. I have solved this problem by separating anodes into several superimposed horizontal elements. These elements are arranged to present as much surface as possible opposite and near the cathode surface. With round elements the entire surface is used in this way.

This arrangement of anodes permits of corrugating the cathode surfaces to conform to the anode surfaces. Obviously a maximum active cathode surface is the result. A cell arranged in this way can produce more output for less expenditure for material and space.

The electrolyte between the electrodes must be saturated at all times. If the flow is not short and direct the brine becomes depleted and the cell efficiency drops at once. The frequent openings between the anodes with the aid of the corrugated cathode makes it possible to keep a saturated brine in the active zone without sacrificing active electrode surface or space.

The chlorine forms bubbles at the anode, which rise. If not deflected out of the path of the electric current these will increase the resistance and the power consumption will be increased. In the Marsh cell the arrangement of anodes and the conforming cathodes effectively deflect the chlorine at frequent intervals in the height of the cell.

As a result it is a feasible and practical thing to economize floor space and equipment by increasing the height of the cell. Heretofore more electrode surface could be obtained only by increasing the area of floor space occupied because, if the cells were made higher, the voltage increased. An increase of electrode surface thus was obtained at the cost of increased power consumption and decreased efficiency.

Within reasonable limits two to three times the usual height of electrodes is practicable with this cell which makes it possible to produce twice as much output per dollar invested than can be obtained in any other cell.

This has been proved by using this arrangement of electrodes in commercial cells. The power lost by internal resistance has been reduced 30 per cent. The capacity of cells by reason of this margin of safety has been increased 50 per cent. Cells have been built with electrodes twice the usual height occupying 2/5 of the floor space and the same output obtained at approximately the same power cost per ton of product. All these cells are full size units and operating in series with the other cells.

Construction Features

The cell consists of three parts, viz., (1) the reinforced concrete structural top or backbone with down-

ward extended ends; (2) the graphite anodes suspended from the top, and (3) the cathode with the diaphragm applied to it, supported and clamped to the cell structure. With the usual accessories and connections for chlorine, brine and electric current, the cell is complete.

The cell may be supported either in a box-like structure when placed in its permanent location in series with the other cells, or by insulated beams with the cathode encased to collect the caustic effluent and hydrogen.

The methods of handling follow the accepted good

voltage never exceeds approximately $3\frac{1}{2}$ volts and averages 3.35 per cent. The energy efficiency varies from 65 per cent. to 70 per cent. for short runs to 60 per cent. for six months' life of diaphragms.

An energy efficiency of 70 per cent. is perfectly feasible because of the low investment necessary for cells and buildings. Every advantage can be taken of all the benefits which result from high energy efficiency, making it possible for small plants to operate on a profitable basis even where power is relatively high.

COMPARISONS PER 1,000 AMPERE 92% EFFICIENCY.

Caustic soda produced, 13 tons yearly.

Chlorine produced, $11\frac{1}{2}$ tons yearly.

Combined product produced, $24\frac{1}{2}$ tons yearly.

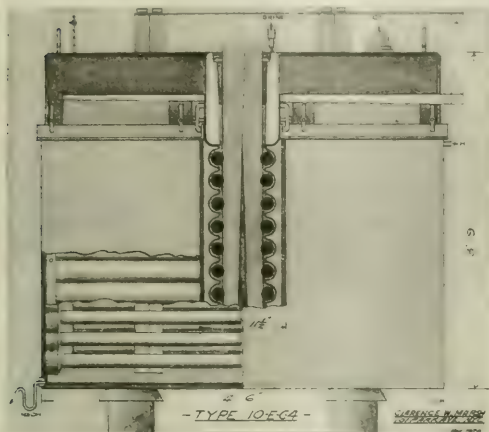


Diagram of the Marsh Electrolytic Cell, 1250 Amperes

practice for storage batteries. The cell is lifted out of its position or out of the supporting box as a unit. The cathode with the diaphragm is removed without disturbing the graphite anodes or any other part of the cell. New cathodes are attached and the cell is ready for operation again.

The active graphite members last much longer than the graphite in the usual practice. At least 50 per cent. to 100 per cent. less graphite is used per unit of product. The graphite needed for posts is even less than this. The extremely low voltage and high energy efficiency accounts for this improvement.

The renewal of the anodes is a simple matter of suspending a new post from the structural top in the place of the old which has been lowered from position. This change takes place about one-half as often because of the higher energy efficiency.

The cells are placed a little over a foot apart, center to center, and are handled either by an overhead trolley, or are simply rolled out of position on a platform truck. Only one-third to one-fifth of the usual requirement for working floor area is required. The cost of a building becomes a very small item.

Commercial tests covering over a year's operation show unusually long life of the ordinary cheap paper diaphragms, viz., six months. The original graphite is still in use after fifteen months' duration. Approximately 65 pounds of graphite are consumed per 1,000 amperes per year. The graphite posts show practically no wear.

The ampere efficiency is of the usual high average obtained in the best practice, viz., 95 per cent. for short runs, $91\frac{1}{2}$ per cent. for three months' operation and 90 per cent. for six months' life of diaphragms. The

1. Power.			
Continuous, 224 hours.			
Usual: 4	KW @ \$80.00...	\$320.00	
Marsh: 3.35	KW @ \$80.00...	\$268.00	
Saved: 0.65 KW			
2. Graphite.			
Usual: 165 lbs. @ 30c.	material and labor...	\$49.50	
Marsh: 68 lbs. @ 30c.		\$20.40	
Saved: 97 lbs.			
3. Diaphragms.			
Average: 3 renewals @ \$5.00		\$15.00	
Marsh: 2 renewals @ \$7.50		\$15.00	
4. Buildings.			
Fixed Charges.			
Average: 24 sq. ft. @ \$5x10%		\$12.00	
Marsh: 12 sq. ft. @ \$6x10%		\$7.00	
Saved: 12 sq. ft.			
5. Cells.			
Deprec'n, excl. Nos. 2 and 3.			
Average: \$225.00x20%		\$45.00	
Marsh: \$112.50x20%		\$22.50	
Saved: \$112.50 in 5 years..			
6. Labor.			
Excl. Nos. 2 and 3.			
Average attendance, repairs and renewals.....		\$56.50	
Marsh—for larger units.....		\$28.25	
Saved			
			\$28.25
		\$498.00	\$361.15
Per ton, Caustic Soda.....		\$38.30	\$27.70
Per ton, Chlorine.....		43.30	31.40
Per ton, Combined Product.		20.40	14.77
			5.63

Augustus F. Blagden, formerly president of the Air Reduction Co., has been elected vice-president and general manager of the American Dyewood Co., and a vice-president of the United Dyewood Corporation and a member of the boards of both companies. He was also elected a director of the New York Quebracho Extract Co.

Robert Grant, Woolworth Building, New York, has formed a chemical division under the supervision of J. P. Allen, formerly district sales manager of E. I. DuPont de Nemours & Co., and more recently manager of the chemical department of Marden, Orth & Hastings Co., Inc. D. H. Litter, many years director of purchases for the Calco Chemical Co., will associate himself with the operation of this chemical division in addition to his other duties as general manager. The new division will do an export and import business in general industrial chemicals and act as agent for American and foreign manufacturers for the sale and distribution of products to the domestic trade. Robert Grant has branches at Glasgow, Shanghai, London, Melbourne, Kōbe, Batavia, Singapore and Calcutta.



POTASH PLANT OF THE UTAH-SALDURO COMPANY, SALDURO, UTAH.

The Domestic Potash Industry

The Enterprise of the Solvay Process Co. in Its Development



BYRON L. THOMPSON,
Manager, Borosolvay, Cal.,
and Salduro, Utah,
Potash Plants.

Foreign Production

Formerly Germany produced almost the entire world's supply of potash, about 95 per cent. of the output coming from the mines at Stassfurt and about 5 per cent. from the mines in Alsace. Practically normal production (about 1,000,000 metric tons of K_2O) was maintained by Germany throughout the war, and, according to figures by Edwards in *Commerce Reports* the total production of actual potash in 1919 from the mines at Stassfurt was 946,000 short tons, or 858,439 metric tons (K_2O). The output from the Alsatian mines in 1919 was 96,546 tons (probably metric). The combined output from Germany and France was therefore 954,985 metric tons. The combined output from the German and Alsatian mines during recent years is shown in the following table:

Potash (K_2O) Produced by the German and Alsatian Mines, 1880-1919.					
Metric tons		Metric tons		Metric tons	
1880	68,550	1911	939,927	1916	883,976
1890	122,302	1913	1,110,369	1917	1,004,281
1900	303,610	1914	903,988	1918	1,003,000
1910	857,883	1915	679,776	1919	954,985

The separation of Alsace from Germany broke the monopoly in the potash industry which Germany had theretofore held.

Imports for Consumption

The following table represents in terms of K_2O approximately the total imports of potash for consumption in the United States during recent years. For the

years 1905 to 1912, inclusive, they have been compiled from a report on the fertilizer industry prepared by the Federal Trade Commission, recalculated from metric to short tons, and for the years 1913 to 1919 they have been calculated from the table of imports compiled from the records of the Bureau of Foreign and Domestic Commerce, United States Department of Commerce.

Potash (K_2O) Imported for Consumption in the United States, 1905-1919.

Short tons		Short tons		Short tons	
1905	129,084	1910	279,780	1915	48,867
1906	155,974	1911	274,446	1916	7,885
1907	144,351	1912	253,678	1917	8,100
1908	136,057	1913	270,720	1918	7,957
1909	173,220	1914	207,089	1919	39,619

Until 1915 practically all the potash brought into this country came from Germany; from 1916 to 1919 it came from many different countries, during 1919 principally from Germany, France, Chile, Holland and Belgium, though that from Holland and Belgium doubtless originated in Germany and France. Unfortunately there is no authentic information at hand concerning the original source of the shipments.

Domestic Production

Potash production from the alkali lakes of western Nebraska exceed that from any other domestic source, although during 1919 only 8 of the 20 plants reported production for the year. At Searles Lake, Cal., the Solvay Process Co. and the American Trona Corporation operated practically the entire year, in addition to which the West End Consolidated Mining Co. was developing its process and plant.

The Utah-Salduro Co., at Salduro, Tooele County, Utah, utilizing the brines of the Salduro Marsh, successfully operated its plant and increased its former production several fold. The Bonneville Co. was reported to be erecting a plant at Wendover, near the Utah-Nevada line, for the utilization of brines from land adjoining that of the Utah-Salduro Co. The Diamond Potash Co., at Arinosa, east of Salduro, was also planning production from this region.

Domestic Potash Produced and Sold in the United States in 1915-1919.

Year	Number of plants	Production		Sales		Value
		Crude potash (short tons)	Available content of potash (K_2O) (short tons)	Crude potash (short tons)	Available content of potash (K_2O) (short tons)	
1915	5	4,374	1,090	4,374	1,090	\$342,000
1916	70	35,739	9,720	35,739	9,720	4,242,730
1917	95	126,961	32,573	126,961	32,573	13,980,577
1918	128	207,686	54,803	140,343	38,580	15,839,618
1919	77	110,243	30,845	173,786	46,732	11,370,445



POTASH PLANT OF THE SOLVAY PROCESS CO. AND PACIFIC COAST BORAX CO. BOROSOLVAS, CAL.

The Salt Lake Chemical Co., with plant at Barmester, Utah, continued production from the brines of Great Salt Lake. The Salt Lake Potash Co., with plant at Kosmo, began production from the same source.

Potash Produced in the United States in 1919, Classified According to Sources.

Source	Number of plants	Crude salts (short tons)	Available potash (K ₂ O) (short tons)	Percentage of total	Total value
Natural brines:					
Nebraska lakes	8	35,733	9,022	29.2	\$1,890,302
Other brines...	6	32,385	11,293	36.6	2,875,908
	14	68,118	20,315	65.8	4,766,210
Alunite	6	6,594	2,293	7.4	683,055
Dust from cement mills	14	11,567	1,159	3.8	233,977
Molasses distillery waste.....	6	8,541	2,802	9.1	801,533
Steffens waste water	9	12,460	3,618	11.7	1,078,291
Wood ashes.....	21	593	358	1.2	202,714
Dust from blast furnaces, kelp and silicate rocks	7	2,370	300	1.0	71,093
	77	110,243	30,845	100.0	\$7,836,873

In the Marysville, Utah, region, the Mineral Products Corporation, one of the pioneer potash companies of the country, continued production from alunite in 1919, though the plant was in operation only part of the year. Some potash alum was produced by one company from alunite, and several companies are known to have shipped raw and calcined alunite either for experiments or for incorporation in fertilizers. The mill of the Florence Mining & Milling Co. was used by several companies for experimental purposes.

Silicate rocks as a possible source of potash continued to receive attention. The Liberty Potash Co. completed its plant at Green River, Wyo., for the utilization of the potash-bearing rocks of the Lucite Hills, but operated only a short time in November and December and closed down on account of technical difficulties. The Eastern Potash Corporation as yet has reported no production from its operations on green sand near New Brunswick, N. J.

It was stated that experimental work on the extraction of potash from Georgia slates was successfully conducted, but that the unstable condition of the potash market prevented the commercial development of this project.

In the early part of 1919 eighteen cement mills had potash-recovery plants installed or under construction. Of this number 14 were in operation, several for only a part of the year. Several discontinued the production of potash at the end of the year.

A very small quantity of potash was produced from blast-furnace dusts.

Only one kelp plant other than the experimental plant of the Bureau of Soils, United States Department of Agriculture, at Summerland, Calif., reported production of potash in 1919. The Government plant, under the direction of J. W. Turrentine, has continued in operation and has extended its experiments to develop more efficient processes for the recovery of potash and of useful by-products such as activated charcoal and iodine. The Bureau of Soils also made a survey of the occurrence of borax in potash materials. Its investigation of the quantity of potash that may be recoverable in the blast-furnace industry of the country was continued during part of the year but has not been completed.

Few developments have been recorded in connection with the production of potash from molasses-distillery waste, beet-sugar refineries, or wood ashes. No production from wool washings was reported for the year.

Borosolvas

Searles Lake, so-called, is a bed of salt, dry on the surface, of about 11 square miles in area, 35 miles southwest of Death Valley, in southeastern California. It has been known since 1873 when J. W. Searles located it and for some time obtained borax there.

It was not until 1912 that it became known that the brine in this deposit contained considerable potash. In 1915 the Solvay Process Company and the Pacific Coast Borax Company united in a joint project for the construction and operation of a plant at this place for the recovery of potash from the brine. Construction was begun in January, 1916, and in April, 1917, the plant was put in operation by G. M. Kohler as manager and F. L. Grover as chemist, both of the Solvay Process Company. The brine is obtained from wells or excavations below the surface of hard dry salt.

Aside from the plant and camp of the American Trona Corporation, 233 Broadway, New York, located a few miles north of Borosolvas on a branch railroad connecting with the Union Pacific at Searles station 30 miles distant, the district practically was uninhabited. While a temperature of 130° Fah. in June and July is a trifle uncomfortable, 110° Fah. is no more oppressive than 85° in Syracuse because of the extreme dryness of the atmosphere.

In addition to the plant the joint owners built the essential elements of a complete village, including a water system conveying water by pipes from mountains several miles distant. The plant requires about 150 men who with their families make a population of about 250. Early in 1920 Mr. Kohler resigned. B. L. Thompson is now manager and H. G. Thiele is plant superintendent.

Salduro

During construction work at Borosolva in conjunction with the Pacific Coast Borax Company, the Solvay Process Company independently erected a small experimental plant on the line of the Western Pacific Railroad where it crosses the Salt Lake Desert about 100 miles west of Salt Lake City. The small plant built by C. L. Griffin and G. M. Kohler was put in operation in July, 1917, with J. L. Silsbee as manager and M. L. Trowbridge as chemist, and continued until February, 1919, when the Utah-Salduro Company was organized.

The original plant was rebuilt and enlarged and in August, 1919, was producing potash and various grades of salt as a by-product. Reconstruction of the plant was under the direction of Byron L. Thompson. H. R. Margetts is plant superintendent. Mr. Thompson was made manager of the Salduro works at the same time he took over the management of the Borosolva plant. There are 200 employees.

A. R. McFarland, chief engineer of the Solvay Process Company, is president of the Utah-Salduro Company. Fred Weindel is treasurer and R. K. Cobb secretary.

There is no similarity whatever between Salduro and Borosolva, although each is in a desert region. Salduro is on a bed of hard, white salt with the nearest land nine miles away to the north and west. Water has to be brought in by tank cars and great care has to be taken to avoid leaks in water and steam lines as all buildings rest on salt and a little fresh water let loose dissolves the salt, leaving a hole which means trouble.

The patent granted to the Utah-Salduro Co. embraces an area of 30,658 acres, the purchase money paid on the entry amounting to \$76,645. According to the Commissioner of the General Land Office this entry covers probably the largest area ever patented under one mineral application.

Future of the Domestic Industry

While the return of Alsace to France relegated Germany with her Stassfurt deposits to a secondary place as the cheapest and most abundant source of potash salts, it nowise has reduced the influence of foreign competition upon the development of a permanent potash industry.

Cost of production is the determining factor in the stability of the domestic industry. While available sources of domestic supply may be considered ample to supply American needs, their development depends entirely upon a foreign industry whose ability to lay down at our ports potash at a price that spells discouragement and defeat to American enterprise never has been questioned. Economic conditions in the Alsatian and Stassfurt fields at the present time as regards rehabilitation, development, fuel, labor, etc., together with probable limitation of production for the maintenance of prices, favor a respite to the domestic industry from foreign interference.

Importations of 39,619 short tons of potash (K_2O) in 1919 were increased during 1920 statistics of which, however, are not as yet available; which amounts added to domestic production leaves a considerable margin between present supplies and the pre-war consumption of about 250,000 tons (K_2O). In this support of firm prices and the general opinion that importations of pre-war proportions will be deferred for an indefinite period lie the encouragement to domestic potash producers to persist in the development of the industry.

Allied Chemical & Dye Corporation

Reflecting similar activity in each of the advanced manufacturing nations and displaying the operation of the integrative process on a scale never before approached in the American chemical industry, the Allied Chemical and Dye Corporation was incorporated under the laws of New York on Dec. 17 with an authorized capital of \$37,326,400 in 7% cumulative preferred stock and 2,143,455 shares of common stock without par value.

The merger of the General Chemical Co. (acids), Solvay Process Co. (alkalis), Semet-Solvay Co. (coke and by-products), The Barrett Co. (coal tar products) and the National Aniline & Chemical Co. (dyestuffs) represents the complete amalgamation of interests already more or less inter-related into what probably is the most self-sufficient and largest chemical manufacturing institution in the world.

The directors for the first year comprise:

W. H. Nichols, Chairman of the Board, General Chemical Co.

W. H. Nichols, Jr., president, General Chemical Co.

E. L. Pierce, president, Solvay Process Co.

H. H. S. Handy, president, Semet-Solvay Co.

Eversley Childs, The Barrett Co.

William H. Childs, Chairman, Executive Committee, The Barrett Co.

Orlando F. Weber, Chairman of the Board, National Aniline & Chemical Co.

William J. Matheson, National Aniline & Chemical Co.

Rowland Hazard, Peace Dale, R. I.

Armand Solvay, Brussels, Belgium.

Roscoe Brunner, Northwich, England.

Emmanuel Janssen, Brussels, Belgium.

The first meeting of the board of directors of the Allied Chemical & Dye Corporation for organization purposes was held on December 21, and the following officers were elected:

Chairman of the board, Dr. William H. Nichols; president, Orlando F. Weber; vice presidents, H. H. S. Handy, Edward L. Pierce, William Hamlin Childs and W. H. Nichols, Jr.; treasurer-secretary, Clinton S. Lutkins; assistant treasurer-secretary, Thomas E. Casey.

Plans for the operation of the new company are yet to be worked out, but it is expected that an announcement as to the policies of the company will be made in the near future. Pending the actual taking over of the various plants and offices by the concern, offices will be maintained at 25 Broad street, with those of the General Chemical Company.

Paper from Rice Straw

At New Liberia, La., the Charles Boldt Paper Mill Co., Cincinnati, Ohio, is building a concrete, brick and steel paper mill, scheduled to begin in June, for the manufacture of corrugated containers from rice straw, heretofore a waste product. At the same place the plant of the Sugar Cane By-Products Co., built three years ago and never operated, has been acquired by the United Fibre & Products Co., which is adapting it to the utilization of sugar cane bagasse and rice straw for paper board. When improvements are completed the plant will represent an investment of \$1,500,000. The United Fibre Products Co. is a Baltimore, Md., corporation, whose officers are Wm. T. Larkin, of Baltimore, president; Cyrus F. Logan, of Washington, vice-president and consulting engineer; Henry L. Brock, of Baltimore, treasurer, and Samuel P. Bowers, of Philadelphia, secretary.

The Consulting Chemist, Chemical Publicity and Some Problems of the Profession

By Edward L. Campbell

B.S., Pomona College, Cal.; M.A., (Chemistry) Harvard University
With The Arthur T. Maas Chemical Laboratories, Los Angeles

WE all have been congratulating ourselves on the great advances made by American chemistry during and since the war. It is now time to consider how much of this advancement likely is to be permanent and what measures are necessary to secure such permanence. We have already witnessed reactions enough in similar situations to persuade us that all gains, no matter how much deserved, desired, or apparently secured are not necessarily permanent, and that a reaction in our own field is possible.

The war, together with less important factors, accomplished three general results of great value to American chemical endeavor. It established a number of new chemical industries of great importance and promoted the rapid growth of others which had struggled along through a previously poorly nourished infancy. It created a demand for the services of a great number of chemists and resulted in an increased appreciation of their services throughout the industries to their financial betterment. Further, through the publicity given to the achievements of American chemists and to the idea that without a staff of thoroughly capable chemists the war could not have been won, it placed the chemical profession in a very favorable light with the general public.

It is altogether probable that a large portion of the newly established and recreated chemical industries will be secured permanently to the country. At least there is evident a very vigorous determination to make them so. If these efforts fail it will be only because public sentiment was not thoroughly enough educated during the war.

Progress of the Profession Predicated on Personal Capacity

The professional gains, however, are far from secure. There is a decided tendency on the part of industry to forget the importance of the chemist, to dispense with his services wherever possible and to make laboratories and technical staffs prominent in the list of overhead charges. This is by no means universal, but where it exists it is very difficult to overcome and we must trust largely to chemists in the more progressive establishments to prove their worth so conclusively that there will be no excuse for such short-sighted policies.

We feel that the most important gain to chemistry, that of aroused public interest and enthusiasm, is likely to be lost. Public opinion and interest are at best variable and unstable; still they are of very vital importance to the progress of chemistry industrially and professionally. These factors only can be maintained in their present favorable aspect by the same means which produced the condition, i. e., publicity and advertising.

Publicity for Chemistry

We know that there is an old-school prejudice against publicity or advertising of any type among all professions, even in this, the age of advertising. This attitude gradually is passing away, for all advertising is properly considered an instrument of education. Much that has been called advertising was not such, but that does not

alter the proposition. No one now-a-days argues against the teaching of chemistry in our high schools and colleges. This elementary chemical instruction unquestionably is an advantage to the chemical industries and to the profession as a whole, but only a relatively small part of our population reach the higher school grades and far fewer go to college, and of the number that do not more than twenty-five per cent. ever take the subject. We have, then, a vast majority of our people who have absolutely no knowledge of chemistry aside from what they pick up from papers, magazines, an occasional popular scientific book or an advertising circular.

Is it then surprising that the commercial chemist finds it an uphill struggle to develop a desirable clientele from individuals who are about equally divided in classifying his services with those of a phrenologist or a shoemaker? Should it be a matter for remark that financial backing always is ready for the wildcat chemical venture, with its glowing prospects, while legitimate, conservative propositions in the same field go begging? Do you wonder that there is not a general public demand for a tariff on dyestuffs, when a large portion of the public still believes that only foreign chemists know how to make dyes?

We must not allow the present generally favorable opinion of chemistry to die out and it only can be maintained and bettered by careful, purposeful publicity. Where is this effort to be made? Since all branches of chemical endeavor will be benefited by it, all should bear part of the burden. Certain groups will be first to feel the benefits, for they are most closely in touch with the public. It is their part to initiate the effort. Foremost among these are the commercial and promotion laboratories. But they must be ably assisted.

Teachers of chemistry in colleges and high schools should make an effort to impress some chemical knowledge and interest on a much larger share of the pupils in their institutions than they are reaching at present, though we know from sad personal experience that they have little enough time for any added work. The profession generally through its technical societies should grasp the opportunity, which is always open, to place in the hands of the newspapers and periodicals items of interest chemically, mingling with the news element always some general chemical information. Societies and clubs should, through the agencies of the technical societies, have on their list of speakers men capable of presenting well some subject on chemistry. Managers of chemical industries should seize the double opportunity of advertising their firms and chemistry simultaneously whenever they have items of news in connection with their work.

We do not wish to be misunderstood in the matter of publicity. All of us have seen articles in the newspapers and periodicals which created serious misapprehensions as to the nature of chemistry as a science. We can do very well without much of the air of the mysterious and miraculous which certain press agents seem to love so much. Mis-statements and exaggerations are detrimental. The less attention and supervision we give to pub-

licity, the greater chance there will be for such mistakes to occur. The only way to eliminate undesirable publicity is to supply enough of the right kind in its place.

Publicity and the Consulting Chemist

So much for our general premise. What we have to say further concerns the position of the commercial and promotion laboratories and their importance in the scheme of publicity. These organizations are the outposts of our profession. They come most closely into contact with the general public and the non-chemical industries. Their methods and conduct, therefore, have an important bearing on the opinion held by many individuals as to the entire field of chemistry. They have taken the lead in educational advertising and they should have the help and appreciation of the entire profession.

The commercial laboratories have grown up in the last two decades. Their development has been slow and it is only recently that they have assumed importance. They serve a very definite need wherever chemical knowledge and services are required. They are often the only source of technical information and assistance open to the general public and the average industrial concern. On the whole the commercial chemists are capable, conscientious and actuated by high principles. The profession has reason to be proud of them; they are in a way pioneers and their lot has not always been enviable.

Misdirected Zeal

There has been a tendency on the part of certain members of the profession to belittle the work of these laboratories. This tendency arises from the fact that the commercial chemist finds himself steering a difficult course between the dictates of professional ideals and the demands of business necessity. It is not strange that under these circumstances individuals or organizations have at times seemed to stray from the highest professional standards. These lapses always have been the result of competition or fancied competition and arose from the lack of co-operation between organizations.

Commercial Fertilizer Chemists Have Established a Precedent

The commercial laboratories have often failed to maintain a scale of fees in keeping with the nature of their work and its real value to the client. They occasionally have failed to maintain a desirable standard of accuracy and service. These failures are detrimental not only to the organizations themselves, but to the profession as a whole. Common sense and common interests point to the need of a much closer co-operation between laboratories for the purpose of (1) maintaining a high standard of accuracy and service; (2) establishing and maintaining, with reasonable uniformity, a scale of fees comparable to the value of the services rendered; (3) educating the general public and the industries to a better understanding of chemistry in general and the functions which the commercial organizations perform.

There is need of a clearer realization on the part of all chemists that the profession advances as a whole; whatever is of advantage to one group is largely of value to all and the converse is equally true. Professional men have a regrettable tendency to lose themselves so completely in the details of the work immediately at hand that they overlook the general aspects of affairs which condition their entire future. They are largely individualists. Is it not time that thoughtful planning take the place of absent-minded optimism in the chemical profession?

Contrast of German With English and American Methods in Low-Temperature Carbonization of Coal

By Stewart J. Lloyd

Professor of Chemical Engineering, University of Alabama

IT is curious to note how developments in low-temperature carbonization have taken different directions in different countries. In England and the United States the production of a smokeless fuel suitable for domestic use seems to have been the aim so far, witness the "Carbocoal" plant at Clinchfield, Virginia, and the production of "Coalite" in Britain.

Germany however appears to have set her heart upon achieving independence of foreign sources of petroleum products, especially in view of the present rate of exchange, and has therefore developed the low-temperature process with the paraffin oils in view for motor spirit, lubricants, etc., and has left the question of smokeless fuel to the future. This is well shown in Gluud's little monograph of seventy pages (*Die Tieftemperaturverkokung der Steinkohle*) which states that over one hundred installations of modified producers are in operation (1919) throughout Germany, all of them yielding the characteristic volatile products of low-temperature carbonization but consuming the solid residue.

Gluud's description of this type of producer (made chiefly by Ehrhardt and Sehmer, Saarbrücken) is very brief. It seems to consist merely of an ordinary producer fitted with tubes through which the coal descends towards the base, where it is consumed. The net result is that the coal in its descent through the producer is kept out of contact with the hot producer gases as they ascend, and hence is not overheated. Also the products of distillation (tar, etc.), are kept separate from the products of combustion, so that it is not necessary to separate the former from a tremendous volume of nitrogen and carbon monoxide.

One advantage of this method of producing low-temperature products is that it does not involve the scrapping of existing producers. They may very easily be rebuilt with tubes, and without much loss of time. Gluud estimates that the remodelling of all such producers would bring on the market in a short time half a million tons of low-temperature tar, from which motor spirit, lubricants, etc., may be extracted.

The only other practical method of low-temperature carbonization mentioned by Gluud likewise recovers the volatile products only. This consists in a modification of the ordinary Mond producer, whereby the temperature is kept down within the proper limits, by the use of excessive quantities of steam. These are made by Thyssen (Mulheim, Ruhr). Here the products of distillation leave the producer mixed with the combustion gases, and the separation is sometimes not easy.

Henry Gettler and William Koppe of North Bergen and Henry Katt of the Town of Union, N. J., have incorporated the North Hudson Color & Chemical Co.; capital \$100,000.

* * *

A. Gross & Co., 90 West Street, New York, with plant on Newark Bay in New Jersey, has acquired the plant of the Virginia Red Oil Products Corp. at Canton, Baltimore, Md., valued at \$600,000. This transaction gives Gross & Co. first place in the United States in the production of saponified fats (red oil, stearic acid) and saponification crude glycerine.

Brief of the Manufacturing Chemists' Association of the United States to the Committee on Ways and Means of the House of Representatives

By Henry Howard

Of the Grasselli Chemical Co., Chairman, Executive Committee

IN the saturnalia of self-seeking now on exhibition at Washington the exposition of the domestic status of the chemical industries from the standpoint of the economics of world trade by Henry Howard, chairman of the Executive Committee of the Manufacturing Chemists' Association, is outstanding for its moderation, judgment and the spirit of fair play.

Protection is not the sacrosanct thing it used to be in our political economics when the American market was far from saturation for the products of domestic enterprise not yet arrived at the maturity of independence. The American manufacturer, particularly with production facilities in excess of domestic requirements and appreciating the importance of full-time, 100 per cent. operation to prices that encourage the widest consumption, now realizes that his richest opportunities come in a fair field that permits no favor.

Every political doctrine conducive to this end is fundamentally sound, with no back-fire or embarrassing ramifications. Henry Howard sees the short-sightedness of a policy that puts the foreign manufacturers of goods of equal quality at an artificial disadvantage. The world is big enough for everybody in it, but it is not big enough for the play of forces that stir up strife. Fair play demands the imposition of handicaps that all who leave the pole in the race for trade in the richest market in the world may carry their proportionate handicap.

Import Duties

I. The rates must be sufficient to protect American labor.

This is fundamental, and is especially urgent at the present time, because with a few important exceptions we are not confronted with the problems of protection for infant industries, but with the task of adequately protecting our highly paid American labor in established industries from ruinous competition with cheap European labor resulting from the combination of the vast armies of unemployed European labor and the badly depreciated European currency.

The problem in its present form is really not alone one of depreciated foreign currency or of low foreign exchange—but of low wages.

For example, German currency and German exchange are at about one-eighteenth their old par value. If German wages were now eighteen times as high in paper marks as they were before the war in gold marks, the low exchange rate and depreciated currency would present little concern for us. But German wages have risen on the average only seven or eight fold in their currency, according to information sent the last of November, 1920, to the National Industrial Conference Board by its investigator in Germany and so, when the barriers shall be down again and trade resumed, if Germany can send her goods to America at the old prices in dollars and get eighteen times as much for them in paper marks as formerly, and produce these goods by paying only seven to eight times as much in wages, it is manifest that what was already cheap German labor before the war has become, roughly, twice as cheap now.

II. We must not place the tariff rates so high that they will prohibit importation.

The tariff should act in general both as an adequate protection to American labor and industry and as a source of revenue to the Government. There are, of course, important exceptions to this rule, as, for instance, when public policy demands the upbuilding of an infant industry such as the dye industry, the reasons for which are too well known to you to need repetition.

To carry out the two principles outlined above it will be absolutely necessary to include in any new tariff some provision that will compensate for the unfair conditions that now exist by reason of the depreciated currency in foreign countries. In devising such a plan the greatest care must be taken not to make it so unreasonably drastic that it will act as a Chinese wall against all importation from countries with highly depreciated currency, and especially must we be careful that such a plan does not unjustly or unfairly discriminate against any one foreign country as compared with another.

Depreciated Currency. Interim Legislation

In addition to the necessity of some similar provisions in the new tariff, we wish to call your attention particularly to the urgent necessity of immediately passing some adequate interim legislation to check and regulate the enormous importations that are now just getting under way, and which are sure to come to us in rapidly increasing volume especially from countries with depreciated currency. If some quick action is not taken we may expect the country to be flooded with imports made to avoid the increases anticipated under a new tariff.

Importance of a Highly Developed Chemical Industry

It is hardly necessary to remind you of the tremendous importance that a highly developed chemical industry bears to the prosperity of any country. Its relative development is perhaps the best index of the progress of civilization in a country. Its high development is always accompanied by utilization of waste products and the building up and creation of new products and new industries that in many cases never existed before, all of which in the aggregate adds enormously to the wealth, prosperity and happiness of the people.

But we must not forget that development of this sort is predicated on continued systematic research carried out at great expense by the most highly-trained experts obtainable. This sort of work is only possible when the industry is in a prosperous condition because it generally requires a number of years before any adequate cash return is realized on the large sums spent in chemical research and development work.

The importance of a large, well-developed industry in acids, alkalis and coal tar dyes in any preparedness program is so familiar to-day at the end of the war that reiteration would be unnecessary.

Medicinal and Miscellaneous Technical Chemicals

The importance of medicinal and miscellaneous technical chemicals has been less strongly emphasized. It is, however, a very important branch of the chemical industry, viewed from the standpoint of the welfare of the nation both in peace and war.

This industry embodies a large, varied and continuous production of every and all kinds of medicinal supplies. The industry is of vital importance to the health of the nation at all times. There must be a complete and comprehensive supply at all times of the normal medicinal requirements, and particularly in time of epidemic, plague and catastrophe such as the country has witnessed from time to time. It is plain that the maintenance of this industry should be fostered to the utmost within the borders of the United States.

The industry is a necessity to the country in time of emergency as it embraces the fundamental and basic products that are consumed by the medical departments of all the military branches of the Government, the Red Cross and similar organizations.

Aircraft depends upon the industry for the indispensable acetate cellulose, for which there is no known substitute, and similar commodities.

Photography depends primarily upon this industry for supplies.

The pyrotechnic program of the Government is founded largely on the ability of domestic manufacturers to supply miscellaneous technical chemicals.

Gas warfare service depends on these products for ingredients that enter into the composition of explosive caps, tracer bullets for light arms and artillery ammunition.

Even smoke screens are based on products falling within this class of material.

It is safe to say that there is not a branch of military service that is not dependent in some manner or another on products in this class of manufacture.

Valuation of Imports

We urge you to consider with great care the suggestion which has come from many sources, and with which we are heartily in accord, that the domestic value be taken as the basis for calculating *ad valorem* rates or for any rates that are in any way regulated by the value of the imported article.

This procedure has been advocated by many of our leading statesmen during the past 100 years, but never in our history has there been a time when its advantages have been so apparent as at present when we are almost the only country on a gold basis and when values in foreign markets owing to depreciated currency are so unstable and distorted and vary in such great degree among different countries that it would be practically impossible to intelligently write a tariff to-day that is based on foreign valuation.

Type of Rate Desired

We believe that wherever it is possible specific rates should be used in place of *ad valorem* thereby greatly simplifying the administration of the act. It is important, however, in many cases to provide two or more specific rates to cover different qualities, for instance Paragraph 73 of the 1909 act provided:

Sulphide of soda, containing not more than 35 per cent of water, 7 cents per pound, or 1 cent per pound, sulphide of soda concentrated or containing more than 35 per cent of sulphide of soda, 3 cents per pound.

In the act of 1913 this dual classification was abandoned and a flat rate of $\frac{1}{4}$ of 1 cent per pound substituted with the result that only the concentrated product, one pound of which was equal to two pounds of the crystals, was imported at a rate designed for the crystal or unconcentrated variety. This concrete instance is given as being typical of a great many and shows the advisability of providing two or more specific rates in all cases where it is possible to substitute a more concentrated or more valuable product for the one in common use at the time the tariff is written.

Importation and Repacking in Bond of Articles for Exportation and the Assembling with Them of Domestic Products

Since 1914 the export of drugs, chemicals and medicines has increased very materially so that to-day we possess a very substantial foreign trade in these articles. The business is now threatened with annihilation by competition with countries which have low labor costs and depreciated currency. It is clear that in order to hold this trade we must adopt some expediency to bridge over the time of readjustment and immediately put ourselves in a position to compete in foreign countries.

It is evident that in many of the articles it will be found impossible for American manufacturers to meet the conditions which have already developed. In our opinion the common sense way of handling the problem is to hold the business by using articles of foreign manufacture when necessary. In order to do this successfully they must be imported in bond, repacked in bond and assembled in bond with the articles of domestic manufacture in which we are still able to compete.

Thus having this business still in our hands, as changing conditions permit, we can gradually introduce a larger and larger proportion of articles of American manufacture. The advantages of this plan are so obvious that we do not think further argument is necessary.

What is "Dumping"?

The act of so-called "dumping" may cover a variety of transactions, some or all of which may prove highly detrimental to American industry. Dumping may include:

(a) The act of importing a single article into the United States at a price less than the ordinary market price abroad.

Dumping of this variety may be for the purpose of relieving a condition of over-production and in this narrow view of the question the treatment and remedy to be applied may involve economic considerations only.

The act of "dumping" may, however, consist of

(b) The Act of commonly or systematically importing given articles into the United States at prices less than the ordinary market price in the rest of the world, and with the intent of destroying competing industry in the United States.

The act of dumping when considered in light of definition (b) may result in importing articles into the United States which compete unfairly with similar articles produced in the United States, and it may be to the distinct detriment of domestic competitors, particularly when the persons engaged in producing, selling, or importing such articles do so under conditions which would render them liable to prosecution under our Anti-Trust Laws, if they were subject to our jurisdiction.

In connection with its request for legislative relief, in 1916, the Manufacturing Chemists' Association presented facts and arguments showing that various products, particularly the intermediates entering into the production of dyestuffs, had been imported into this country at prices below the cost of production, and under conditions which showed a specific intent and purpose of destroying competing industry in this country.

It was further pointed out that, by reason of the world-wide monopoly obtained by German interests, it was possible to control the markets for coal tar products in this country by imposing terms and conditions upon American consumers whereby they could only obtain the product from abroad provided they dealt exclusively with the agents of foreign importers to the detriment of producers in this country.

It is thus apparent that the subject of "dumping" is broad in its scope and requires careful analysis and consideration in order to apply a remedy which will not only protect the domestic manufacturer against the ordinary cases of under-priced articles, but will also fully and adequately protect the American consumer against the sale of articles which are designed to restrain trade and unfairly compete with home-made products.

Canadian "Dumping Clause"

The Canadian Tariff Law since 1907 has contained among its other provisions a provision assessing a special duty in the case of dumping. The Canadian law in substance provides that in the case of articles exported to Canada of a class or kind produced in Canada, if the export or actual selling price to the importer in Canada is less than the fair market value of the same article when sold for home consumption in the country of origin, there shall, in addition to the duties otherwise established, be levied, collected and paid on such articles on importation into Canada a special or "dumping" duty equal to the difference between the selling price of the article for export and the fair market value thereof for home consumption. Such special or dumping duty is levied, although the article is not otherwise dutiable. The Canadian dumping provision is limited to 15 per cent. *ad valorem*.

It is apparent from the above that the Canadian law is not drastic. It has been in effect for 13 years. It has been amplified by decisions and regulations and the Manufacturing Chemists' Association is credibly informed from many sources that the Canadian Dumping Law has worked satisfactorily.

So far as the Manufacturing Chemists' Association has been able to ascertain, no law yet passed by any country has had as immediate and as beneficial an effect as the Canadian Law, which automatically places a fixed duty at the moment of importation.

The present law of the United States regarding unfair competition* is clearly an attempt to define those particular acts of "dumping" which go beyond the mere act of importing and selling at cheap prices in this country to relieve a condition of over-production abroad. To the extent that Congress has endeavored to define specifically the acts complained of, and to the extent that Congress has provided not only a criminal penalty, but also under certain conditions a doubling of tariff duties, the results cannot be other than beneficial.

The prime and inherent difficulty of our Federal Law as it exists to-day is that, owing to the difficulties of enforcement, the law has no force or effect. It is true that the Secretary of the Treasury, under the Act of September 8, 1916, has authority to make regula-

tions. No regulations, however, have yet been made which are adequate, and it is doubtful if any regulations can be made under the existing law which are sufficiently comprehensive and at the same time sufficiently automatic in their application to render a real protection to the American manufacturers suffering from the acts complained of.

Australian Law and Practice

The Act of Congress as it exists is in some respects modeled upon the Australian Law. The Australian Industries Preservation Act contains provision in part 2 for the "prevention of dumping." The Australian Act is premised upon the same theory as the Act of Congress, namely, upon the theory of unfair competition by the importation into Australia of goods with intent to destroy or injure Australian industries, the preservation of which is advantageous to the Commonwealth of Australia. The procedure in Australia for proving an act of dumping is probably no better than our own and would seem to be cumbersome. The Australian remedy, however, would seem to be much more complete. It is provided that, upon the publication in the Australian Official Gazette of a decision against an importer, the goods in question are automatically by such publication placed on the list of prohibited imports.

Imported Sires for the American Dye Industry

The suggestion in September CHEMICAL AGE that the importation of skill would be more advisable than the importation of foreign dyestuffs consequent upon a lagged development of experience in those lines wherein American production may be deficient has been acted upon by the E. I. Du Pont de Nemours & Co.

Dr. Otto Ranger, accompanied by his family, and Dr. Joseph Flachslander, both graduates of the University of Munich, arrived in New York during the holidays and are now installed at Wilmington, after several days detention at Ellis Island to allow the immigration authorities to confirm their representations that they were dye experts engaged by the Du Ponts at salaries of more than \$25,000 a year each.

Dr. Robert E. Rose of the Du Pont organization, in explanation of the policy of the dyestuffs division in importing foreign help, stated that the domestic dyestuffs industry is equipped to produce 85 per cent. of the dyes required for American consumption and that the remaining 15 per cent. can be made if allowed time to develop special processes under favorable auspices, which he puts at 3 to 5 years when the American industry can compete effectively with whatever foreign competition may remain after that period. Dr. Rose placates American chemical talent by explaining that German chemists were employed by the Du Pont Co., not because American chemists fear their inability to solve the necessary special processes, but because the company sees in foreign help a short cut to the discovery of the remaining formulae and practice that must be developed.

The Everly M. Davis Chemical Corp., 480 Lexington Ave., New York, announces the beginning of sulphuric acid manufacture at Picron, the former projected government picric acid plant near Little Rock, Ark., from Louisiana and Texas sulphur. The manufacture of aluminum sulphate also is in contemplation, an outlet being seen in the growing paper industry in the South.

*Federal Revenue Act, Title VIII., Sections 800-804. Approved Sept. 8, 1916.

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A Consolidation of
The Chemical Engineer
and Chemical Age



THE trustees of the funds of a tax-ridden people gambling on margin for a rise in a bear market is the spectacle presented by a repudiated administration in enacting legislation to commit the American people not only to a policy of manufacturing a commodity for the benefit of a class under conditions that violate every instinct of business prudence, but to a precedent for the nationalization of industry whose logical eventuality, if not the condemnation for the benefit of agricultural interests of the plants of the International Harvester Co., would be the use of arsenals in peace time for the manufacture of agricultural implements, or of such products as any special class who at the time may be in dominance may require.

A glaring defect of our governmental system is the tardy reaction of the machinery of government to the commands of the people.

The socialistic taint of an administration that Hoover said since the armistice has failed by every test that can be applied erupts in a Senate vote of 30 Democrats reinforced by 4 Republicans against 27 Republicans plus 2 Democrats to create a government corporation to manufacture, at a loss borne by the public, ammonium sulphate for fertilizer, which ingredient constitutes 2 per cent. in quantity and 10 per cent. in value of all fertilizer ingredients used, in competition with established producers until war may require its utilization as nitrate for explosives.

We are an individualistic people well acquainted with the incompetence of government in business management and demand that the dead head of political bureaucracy be kept off of private enterprise.

Important as nitrogen preparedness is to national welfare, it shall not serve as a vehicle to carry any socialistic scheme to sap individual initiative of the essentials of progress.

We will have nitrogen preparedness in the logic of events without the mess and muddle of government in business.

AT a time when the deflationary process should be encouraged in order that all elements entering into the cost of production may feel its influence and that a stable basis for the resumption of business may be attained, special interests beseech government that they may be exempted from its operation by the imposition of import duties of such magnitude as not only will impede its general progress in domestic business, but will aggravate the world-wide situation of which our own experience is a part.

Under present conditions of world trade, America is the dearest place in which to buy and the highest market in which to sell.

The handicap to export sales imposed by economic law, because of differences in international exchange, would be increased in many lines to the point of extinction of export trade by a so-called protective duty that denies to the foreign consumer the opportunity to pay in goods and thereby to contribute his part to the return of normal exchange and of all that it connotes in a broken and disturbed world.

In all this commutation to Washington there is too little thought given to the consumer in the face of the power he has displayed in his present strike.

It ill becomes our eminence as the richest nation of the world that we wish to lay our neighbors under tribute to consume our surplus production, attained under conditions unmatched for favor, and yet to deny them an opportunity to play their indispensable part if the fabric of civilization is to persist.

IT is not to be wondered at that ignorance and inefficiency should look to some power outside of themselves to shield them from the play of forces to which we all are subject.

Their legislative representatives in numerous instances are economic mountebanks who may think that in unscientific legislation, like the incantations of the medicine man, they can conserve to the tribe advantages and benefits that Nature rules shall pass to all.

Our position today as the chief creditor and the foremost manufacturing nation of the world compels the considerate attitude of the prudent mortgagee towards the holder of an uncertain equity that can grow in value only by the former's forbearance.

The unwisdom of denying the debtor an opportunity to increase the security of the mortgage is obvious.

Nature compels us to help others in order that we may benefit ourselves.

PRESENT international relations make industrial efficiency in its every aspect the intimate, pressing problem of every technical man.

It is not to our benefit that the necessity for greater intensive work in this direction should be relaxed by artificial barriers.

Here lies the logical protection to American industry and the opportunities for technically educated men.

It denies to none in stricken lands the chance to work and grow, and in its encouragement to the less fortunate we find added stimuli to further achievement.

THE service rendered the world by Great Britain in her development of backward regions was not only of vast reciprocal benefit, but laid the foundations of our present international relations.

In our ascendancy in finance and trade, based upon an unexampled productivity, the obligation to continue this service, to a large degree, has passed to us.

To prosper we must produce; to continue production we must sell; and to live the principle that the only satisfactory transaction is one that benefits both parties, we must buy.

The time is past when, with our productive skill, resources and the crying obligations that come with power, we can deny to others the opportunity of growth and to ourselves the stimulus to further material achievements.

Protection as a political principle has served the nation well, but to persist in manhood the use of a tool of youth is a confession of incapacity to meet the competition of the world that belies the facts.

THE hands of man are raised in menace and distrust at him who would enslave the world; yet the world's recovery from its nightmare rests upon his recuperation.

When cancellitis was at its height, a perturbed soul declared that what the world needs is religion.

In the clash of conflicting interests, whether back on the farm, in the shop or bank, in the Senate or the chancellories of empire, one great rule works with unflinching results. The more you help others, the more you help yourself!

PURCHASING power depends upon production, whether of an individual, an industry or a nation, and demands for its free expression an equitable and stable basis of exchange; for goods exchange for goods and any variation in their value not freely and fairly transmitted disturbs the equality of purchasing power which is the basis of business.

This lack of balance in the exchange of products of our own industries creates the present domestic stagnation and arises from the thwarted operation of a natural process which must run its course before general activity in production will be resumed.

This stagnation has its inception in abnormal international exchange, which likewise arises from the same lack of balance between larger units.

With this diagnosis accepted, what is the treatment? Plainly the prompt determination and settlement of the German penalty, that a race of perverts with a genius for production may work out its fine and to that great degree restore by the creation of goods the disturbed balance of the world.

PURCHASING power is a function of the standard of living.

A nation's first duty, like that of an individual, is to itself, for without the cultivation of good husbandry a nation neglects not only a duty to its people to advance the standard of living, but to civilization that it may become a force in its progress.

Our people have the highest standard of living and the greatest per capita purchasing power, hence the American market is the richest in the world.

Attention is directed to Henry Howard's summary of the doctrine of Protection as applied to the chemical industry in his brief as Chairman of the Executive Committee of the Manufacturing Chemists' Association before the Ways and Means Committee.

In Mr. Howard's injunction not to place the tariff rates so high as to prohibit importation, he imposes a responsibility that directly affects the rôle of America in the material salvation of the world.

THE development of an independent and self-contained dyestuffs industry in America is a prime requirement of the instinct of self-preservation, and to that degree such enterprise is differentiated from any other in our present state of national progress.

Recent experience has compelled the advanced manufacturing nations to encourage the domestic development of this industry that they may be independent not only in munitions in event of war, but in the intimately essential and pervasive service rendered by it and its allied industries to the national economy.

The precedent of Great Britain in prohibiting for a period of ten years, save for transshipment or resale outside the Empire, the importation of all synthetic dyestuffs and intermediates except those not produced in her own plants in satisfactory quantity and quality, is an unanswerable argument for similar prompt action by our own government.

UNEMPLOYMENT is Nature's lash to compel the human element in production costs to get in line with raw materials, and like every step in progress is not without pain.

We, hired man or boss, are simply instruments of public service, and when that service is not permitted to function the tools, for the time, are laid aside.

During the past decade, with a population increase of 13½ per cent., our production capacity increased over 30 per cent., which is far in excess of the growth of our ability to consume.

Shall we wait for our own population to catch up, or shall we, as a nation, with the world suffering from under-consumption, engage in the greatest philanthropy of all time—to help profitably broken and discouraged peoples to help themselves?

Idle plants, idle workers, reduced consumption, business instability, distress unto starvation in many lands, call for such aid as human ingenuity can devise and human character support that people everywhere may work and heal the wounds of war.

American Institute of Chemistry

Observations on the Project and Answers to the New Jersey Chemical Society's Questionnaire

ANALYTICAL work involves a measure of manipulative detail that imparts to it some of the characteristics of a craft, and demands for reliability and accuracy that proficiency that can be acquired only by experience.

This experience means repetitive work, with its incidental monotony, which in course of time becomes irksome to a degree that is determined primarily (1) by the man's capacity for work involving initiative and the exercise of judgment in the handling of men and the larger instruments of production, and (2) by his enterprise to find a congenial outlet for the pent-up Utica of his powers.

Hence the time that the industrial chemist spends in the laboratory as a routine analyst is a probationary period in which is determined his suitability for advancement in the industry.

The Plant Laboratory Serves, as a Sieve

Appreciation of lack of fitness because of uncongeniality of the work may be born of the man's consciousness, and he betakes himself to other employment wherein often his chemical training may stand him to but little advantage beyond its disciplinary value.

On the other hand, the analyst determined to utilize his chemical education to the best advantage finds in this probationary service in the plant laboratory many opportunities to orient himself and to qualify for advancement in the direction that most appeals to him. Therefore, the industrial chemical laboratory not only is the logical avenue of introduction into industry of the chemical graduate, but provides the opportunity whereby his technical training most quickly can be utilized to transform his inexperience into that measure of capacity upon which progressive earning power is based.

As relates to his college experience, the plant laboratory is the post-graduate disciplinary school of the technical novitiate; as relates to the industry or the man's life work it is a primary school.

The fact that a young man has had spent on him several thousand dollars and has devoted several years of the most impressionable period of his life in acquiring a technical education, does not entitle him to consideration other than what inheres in the results of his work. The universal law is that the more is given to a man the more is expected of him in the direction of his gifts.

What we wish to impress here is that service in the plant laboratory is an episode with men capable of growth and responsibility in the work of production. The limitations of many do not warrant advancement beyond this stage.

Industry's Requirements of Trained Men

The chemical and allied industries require for their perpetuation and growth the yearly accession of hundreds of chemically trained men who are the product of institutions devoted to their training. The trained youths of today twenty years hence will be the leaders in the work of production. Youth is scrutinized for the indicia of creative capacity and provided with every opportunity possible in a competitive system for the display of ability.

Where the selective process works with high-class material, i. e., material created by the expenditure of time and tribute that dignify it with the characteristics of a profession, decent opinion demands that its creation and utilization be with such judgment as may reduce to a minimum the percentage of waste.

We would not minimize the essential character and importance of chemical analytical work to the growth of the industrial arts and to the enforcement of a great body of federal and state laws designed primarily to protect the consumer and reacting to the standardization of the numerous chemical industries affected. The Association of Official Agricultural Chemists exists to improve and standardize analytical methods and represents the healthful functioning of a desirable purpose.

Government in its numerous federal and state activities is a large employer of analytical chemists. In fact our federal government is the largest employer of chemists in the world.

What we do wish to emphasize is that, in the play of individual ambition and its relations to men and things, the analytical chemist, by and large, is a transitional character in our industrial economy.

The personnel and duties of this type of worker constitutes, as it were, a reservoir fed by the institutions for chemical training and within whose reaches work the influences that determine the fitness of the individual for conscription to the various duties in the production and distribution of goods, and from which reservoir he emerges chastened largely of his conceit and more fitted for responsibilities in the respective industries.

WHEN you tie up the chemist with the basic problems of production, transportation, trade and finance, you not only widen his outlook, but make possible by his economic organization an independence and a self-respect that compel the consideration of others, organized in the same way in other lines, whose work is predicated upon the knowledge of the chemist as individuals.

The chemist will never come into his own in a big way in any community until he hooks up with the big problems and the big men who are working out the salvation of the community in their solution.

The trouble that afflicts people also afflicts chemists; there are so many of us too little to be big and so few of us too big to be little. Out of the mass of mediocrity emerge the broad-visioned men.

The recognition of the chemist as an important factor in material development is the work of the latter group. So long as chemists flock by themselves and remain apart from the problems of the State will their appreciation be confined largely to themselves.

Organizations of chemists embrace but a small part of those identified with the chemical industry. Where the personnel of the organization is exclusively chemists much good has resulted and will result to the individual from such segregation. But only when the appeal is broader and the interest more embracing can we look for the more intensive expression of aptitude and talent which we have a right to expect from the chemist as an educated man.

—Editorial, *CHEMICAL AGE*,
December 10, 1919.

The proportion of chemically trained men who remain analysts throughout their working usefulness is very small.

Conservation of Technologists

Always a prime consideration with the conscientious production manager is the proper placing in the plant of the men who display aptitude for the work and a disposition to be fair to the management, to the end that he may strengthen his organization in capacity and thereby reduce production costs.

How infinitely more important and desirable it is to American industry to give to the raw material of its future managers who must have chemical knowledge and experience a corresponding scrutiny! What could be more fitting and would be more drastic and what would reflect more the individual initiative and enterprise of American industry than to have this scrutiny promoted by the subjects themselves?

Production in America is a tri-partite relationship involving (1) the man who teaches the technical novitiate, (2) the man who hires him and who has "arrived" and (3) the novitiate himself, in process of arrival.

To conserve chemical man-power, to place men where they can do the most for the industry, and hence for themselves; to weed out incompetence and reward the worthy; better, to deflect it in its incipency before it can exert baneful influence on morale to say nothing of its uncertain response to the time and study of the technical teacher; to direct the apt where their aptitude can be most productive; in brief, to improve the breed of chemical administrative men by enlisting the close co-operation of the three elements involved in chemical production, is as fine a problem as could be set before these alert and progressive groups and one to which their reaction to the desirability of its progressive solution should be prompt.

It goes without saying that Dr. Hollis Godfrey, chemist, 1898, Massachusetts Institute of Technology, president of Drexel Institute, Philadelphia, Pa., Chairman, Council of Management Education, would approve heartily of the formation of an organization of the character thus briefly suggested, because he would see at once in such a closely unit institution an instrumentality for the advancement of the purposes of the Council of Management Education. Your attention is directed to a perusal of his article, "Co-operation of the Colleges and Industry in the Development of Managerial Ability," in the November number of *CHEMICAL AGE*, for further elucidation of this important aspect of the subject.

Many Men of Many Minds with a Common Purpose

Factory chemists, superintendents and production managers, as a rule, are people of one-sided development. Their association with chemical salesmen always eager to learn some effective talking point about the goods and their utilization; their association with alert teachers of technical men, equally eager to improve the efficiency of their work that their product may be more readily absorbed by industry; their association with men of every type identified with chemical manufacture and merchandising, whose outlook may be as broad and their vision just as inspiring, would result not only in their broader individual development, but in increased efficiency resulting from stimulated resourcefulness.

There is not a problem in production or distribution in the chemical or allied industries from safety and sanitation to salesmanship and shipping that would not

fall properly within the purview of such an organization.

We have emphasized the three essential elements of this proposed organization, viz., the chemical teacher, the chemical subordinate and the chemical boss.

Accordingly, a national organization of these types of essential elements of the chemical and allied industries should be governed by a body of delegated powers elected by subordinate sections, based upon state lines, and embracing those within a given state identified with chemical education, manufacturing and merchandising, and qualified for membership.

Thereby would the community spirit in the industry be developed. Not only would ability to serve the state thus be acquired, but the state section or society would take its legitimate place among similar organizations concerned with the manufacturing, commercial and financial interests of the state.

On broad lines has been sketched the writer's conception of an organization that properly may be called the "American Institute of Chemistry." The contribution of this opinion may serve to coalesce into something tangible that for which the time is ripe.

The New Jersey Chemical Society Questionnaire

Should an Institute of Chemistry be established?
"Yes."

I. A. Should it function as outlined in the circular?

In the circular distributed by the committee of the New Jersey Chemical Society, of which Dr. F. D. Crane, 74 North Willow street, Montclair, N. J., is chairman, the proposed functions of the American Institute of Chemistry there suggested fall naturally within the purview of such an organization as outlined and on proposal properly would be assigned to a committee to study and report.

B. What else, if anything, should it do?

What an organization does, or what its members get out of it depends entirely upon what they put into it; and the organization will be no bigger than the calibre of the men who direct its destinies.

C. Should it be constituted as outlined?

It should be a national organization founded on state lines after the manner of the federal constitution, with the needed simplification of making the presidents of the state sections the supreme advisory committee of the national organization, and which by the delegated authority of the respective state sections would elect the officers of the national organization—to the end that progressive selection of quality shall be assured, with that maximum autonomy in state government that provides quickest response to the stimuli of the local environment.

The governing body, both in the national organization and the state sections, should be made up of (1) the teaching chemist, (2) the production chemist, and (3) the business chemist, all alert to the problems that beset the industry and the good that they can do.

The nation and the states in their statistical, development and research departments need the quick co-operation of an organization of the elements of the chemical industries that could speak for the industries, because they constitute the industries. Existing commercial, financial and manufacturing organization of the respective states would find in this proposed organization a worthy complement of their activities and of equal dignity in their community of purpose.

Such proposed organization, being fundamentally of an industrial or business character, would be unmatched for the opportunities provided to its numbers

for the display of aptitude and talent predicated on technical education or experience in industries resting intimately in applied science.

In his closeness to a condition demanding correction, and in the democracy of an organization designed for this accomplishment, he could see that its activity would reflect his own enterprise, and hence bring out the nascent attributes inherent in every ambitious man.

Contact with his fellows, friction of ideas, competition in a common service, contribute to the recognition of capacity often in directions unrelated to one's daily duties, and serve to mark a man for recognition and for placement where his native capacity may have expression.

D. How should it be financed?

By a membership of say \$5 per year at the start, distributed over the state and national organizations.

II. If not, should anything be done?

Every chemically educated man alert to needs of the day and the drift of the times will answer this question in the affirmative.

A. What?

The American Institute of Chemistry would be a chemical industrial organization for chemical industrialists. It would be organized expressly to benefit no particular group or class of chemical workers, only in so far as such benefit would redound to the benefit of the industry. An important function would be the reduction of human waste in the preparation of chemical men for administrative work, logically following which would be helping men to help themselves.

If they cannot satisfy this primal requirement, how can they help anybody else, which would be the primary purpose of the organization, viz., service to the State from the body of the industry.

Recent Advances in the American Sulphur Industry

By Raymond F. Bacon, Director, and Harold S. Davis, Industrial Fellow,
Of the Mellon Institute of Industrial Research of the University of Pittsburgh

SULPHUR plays a more basic rôle in chemical industry than any other element. Either as elementary sulphur or combined as a metallic sulphide, it is the source of all sulphuric acid. Hence any changes in the sulphur industry should be of great interest to the chemical engineering profession.*

America Dominant in Sulphur Production

America now dominates the sulphur industry and virtually all the American sulphur is produced by three companies, viz., the Union Sulphur Company, the Freeport Sulphur Company and the Texas Gulf Sulphur Company. These three companies produce not only virtually all the sulphur used in the United States, but also a considerable surplus which is exported. The only other sulphur which normally enters the American market in quantity comes from Japan¹ and its percentage calculated on the consumption of the United States is small and is not likely to increase. Rising costs of living have meant much higher wages in Japan, as well as in other parts of the world; in fact, the percentage increase has probably been greatest in Japan, due not only to world conditions affecting all countries, but to the rising standards of living of the Japanese. These facts, together with present higher transportation costs, will make it increasingly difficult for Japanese sulphur to compete on our Pacific Coast with the American product.

Opening Up the "Big Dome"

During the World War, and especially after America's entry into it, the demand for sulphur grew enormously. Some time previous to our declaration of war, consideration had been given by a certain group of New York capitalists to the opening up of the sulphur deposit known as the "Big Dome," located near the city of Matagorda, Matagorda County, Texas. These plans were hastened to realization by our Government's need and demand during the war for the maximum production of sulphur from every possible source. The plans eventuated in the formation of the Texas Gulf Sulphur Company, which, however, did not get its plants into

operation until after the Armistice. Production has been practically continuous since the company first mined sulphur on March 19, 1919.

The plant of this company, which has been described elsewhere,² was designed to have a capacity of 1,000 tons of sulphur per day, but for months at a time, during the past year, it has produced on an average 2,000 tons per day. The total production for the year 1920 exceeds 800,000 long tons, while in all probability the production for 1921 will be the largest of any sulphur company in the world. The possible daily production with the present plant, under favorable conditions, could be forced to three or four thousand tons per day. The deposit contains upward of ten million tons of sulphur.

Description of the Deposit

The main deposit has a diameter of about 4,000 feet and is situated 800-1,000 feet below the surface of the ground. The sulphur occurs in an almost flat stratum whose general shape is like that of a flat-topped umbrella. Above the sulphur stratum is an unconsolidated sediment consisting of bands of shale, gumbo and boulders. Below is a layer of salt and gypsum, and then a layer of salt of undetermined but very considerable thickness. The sulphur content of the deposit runs quite uniform with a slightly higher percentage of sulphur on one side of the dome. The mining operations are carefully checked, and a large-sized model of the deposit enables the engineers constantly to visualize what is taking place underground.

Market Conditions

At the time the Texas Gulf Sulphur Company entered the market the situation was about as follows: The Union Sulphur Company had on top of the ground, in unsold stock of sulphur, upward of one million tons and the Freeport Sulphur Company had several hundred thousand tons. The normal consumption of sulphur in the United States had been between four and five hundred thousand tons per annum, which quantity could be readily supplied by the two older companies.³ A new

*Eng. Min. J., 197 (1919), 5357. Chemical Age, Vol. 1, No. 1, pp. 33, 37.

²It may be stated in passing, that any economic data given regarding either the Union Sulphur Company or the Freeport Sulphur Company are subject to the usual statements on advertisements of bond sales, that is, "they are gathered from sources we believe to be reliable but are not guaranteed by us."

³It is interesting to note that the New Orleans, La., office of the American Institute of Chemical Engineers, which is the source of the information on Japanese sulphur, is being organized for the coming year.

sulphur company entering the market with a large production of sulphur was, therefore, compelled to pursue one of two policies, viz., (1) either to attempt to obtain a share of the business by cutting prices, or (2) to place the sulphur in markets which had not hitherto used sulphur; in other words, to increase the sulphur consumption of the country.

With reference to the first possibility, competition based on cut-throat slashing of prices always has proved disastrous to the whole industry. Moreover, the mining of sulphur by the Frasch process, to be carried out economically, must be conducted on a very large scale, so that even if a company, under the conditions outlined above, had obtained a third of a possible 500,000-ton consumption, this would not have insured profitable operation. The company has chosen what is surely the wiser course in attempting to place its sulphur by increasing the total consumption in the industries. It was possible to do this owing to the prevailing economic conditions.

The United States had in recent years consumed annually for the manufacture of sulphuric acid upward of 500,000 tons of sulphur in the form of pyrites, most of which came from Spain. The older sulphur companies, either because of some agreement with the pyrites importers, or because of a desire to hold the price of sulphur at a certain level, had not attempted seriously in past years to substitute sulphur for pyrites as the raw material of sulphuric acid manufacture. Importation of Spanish pyrites, due to war transportation conditions, fell off very seriously during the war years. This caused many producers of sulphuric acid to discard the pyrites roasters and to install sulphur-burning equipment, while new producers in this field erected plants which were almost entirely so equipped. The new company was able to obtain its fair proportion of the new business and the net result has been that the total consumption of sulphur of the United States during the past year has been upward of 1,000,000 tons, as compared with a normal consumption in recent years of about half that figure.

Some Sulphur History

It is interesting, in this connection, to give just a little history, for if the subject is examined it is found that, in the early days of sulphuric acid manufacture, all the sulphuric acid of Europe, excepting Nordhausen acid, was made from brimstone. This includes the period from about 1750 to 1839, when pyrites first was used commercially for the manufacture of sulphuric acid in England. This use of pyrites was due to the fact that the Neapolitan Government, in 1838, granted a monopoly for the exportation of sulphur to Taix & Company, of Marseilles, which firm immediately raised the price of sulphur from \$25 to \$70 per ton. By so doing, it killed the goose that laid the golden egg, for pyrites was substituted immediately for sulphur in most European countries and the era of high-priced sulphur was but short-lived. The subsequent history of the sulphur industry is one of violent ups and downs.

If one considers this history up until some time after Frasch made America a factor in the business, it will be noted that it has been characterized at all times by short periods of prosperity, followed by a short-sighted, selfish, destructive competition on the part of certain interests. Following this would come a period of such marked depression as to threaten the life of the entire industry and it would be necessary for some governmental or other outside agency to exercise pressure to get the producers together on a common-sense

basis and thus gradually put the industry on its feet.¹ Since the time when Frasch made possible America's sulphur industry, the stability of the whole industry has been much greater.

While at the present time there is an extremely lively competition among the companies for business, there is every reason to believe that American common-sense spirit of fair play and co-operation will prevent this competition going to the extent of threatening the industry itself, as has happened many times in the past. Present indications are that all the sulphur companies are pursuing an enlightened policy, in that all are doing more or less research and development work, having as its ultimate object the opening up of broader markets for sulphur, of which sulphuric acid manufacture affords but one.

Advantages of Sulphur

For sulphuric acid manufacture sulphur has many very marked advantages over pyrites. Using pyrites means handling in the works a comparatively large quantity of material, its slow combustion in expensive roasters, a certain inevitable dust nuisance and the disposal of a large tonnage of cinder. As against this, sulphur of less than one-half the weight of pyrites, for a given tonnage of acid produced, is handled in the works, is burned cleanly in inexpensive equipment and leaves no residues to be taken care of. Sulphur is constant in composition, and its freedom from arsenic and other impurities allows the production of a purer acid. It is also claimed that, in practice, the burning of sulphur means a higher rate of production for a given size of lead chamber space.

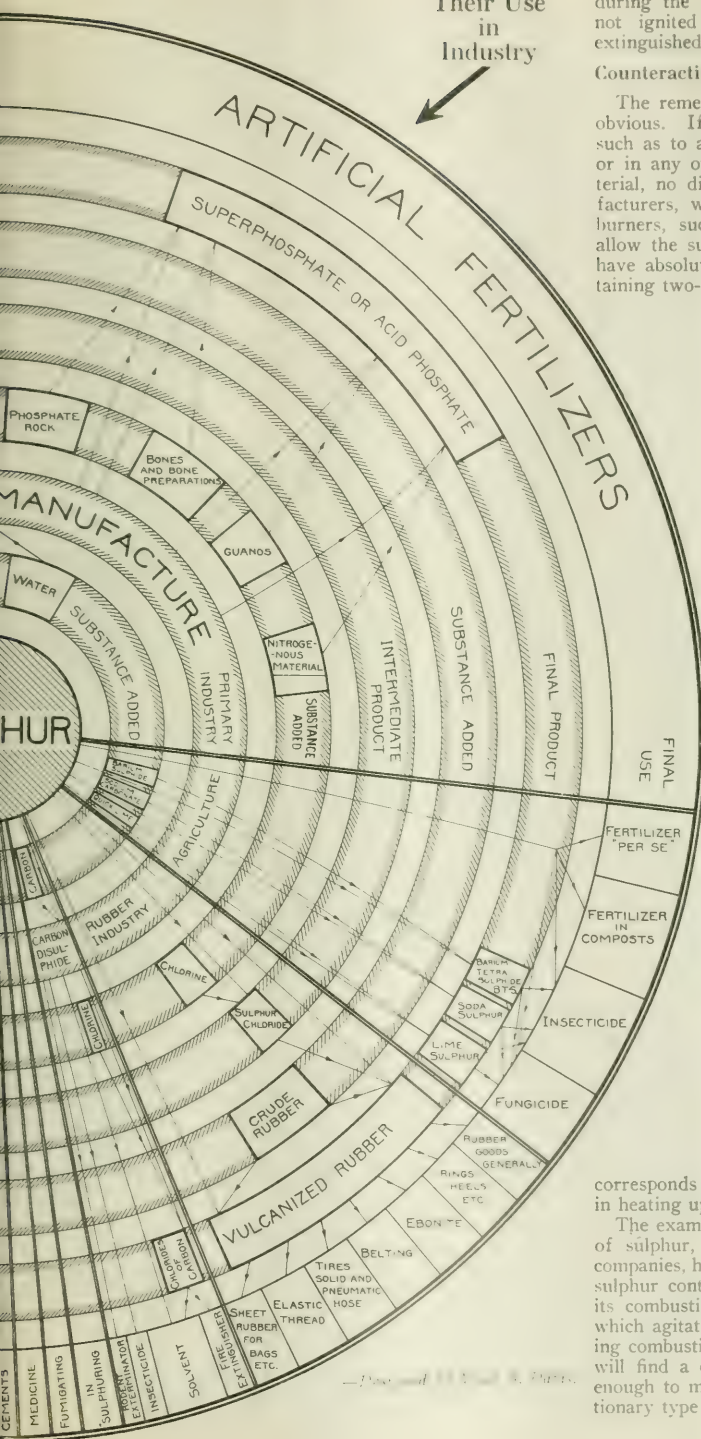
These acknowledged advantages of the use of sulphur over pyrites for sulphuric acid manufacture have been demonstrated by the willingness of acid producers to pay a higher price per unit for elementary sulphur, as compared to sulphur in the form of pyrites. An example of this is the fact that one of our largest and best organized chemical companies, in making a large contract, chose sulphur over pyrites for sulphuric acid manufacture, where the differential in offered prices was 8 cents per unit of sulphur.

When one considers the present high prices of labor, the uncertainty of the copper market and the fact that sulphur may be purchased in a competing market from concerns which have large stocks on hand, so that delivery is certain, it would seem to be a wise business policy to use sulphur rather than pyrites for sulphuric acid manufacture even with a very large differential in price. This is especially true when one considers the other side of the situation, namely, that, in buying imported pyrites, the consumer is putting himself at the mercy of one large set of interests which, while it may at the present time offer pyrites at low prices, and even below actual cost, will almost certainly at some time in the future reap its profit by much higher prices.

It is said that imported pyrites has been offered for large contracts in this country at about 10 cents per unit of sulphur, ex-vessel, Atlantic seaboard, while at the same time pyrites was selling in England, much nearer the base of supplies, at 20-22 cents per unit of sulphur. It reminds one somewhat of the tactics of Standard Oil in the old days before "trust-busting" became fashionable with politicians; and everyone knows that those who bought cheaply when the company was extinguishing a competitor never reaped any

¹U. S. Bureau of Mines, *Report of the Director*, 1919, p. 10.
Chem. Eng., 1921, 18.

Their Use in Industry



during the burning of the sulphur that this film is not ignited and consequently the whole flame is extinguished.

Counteracting Its Influence

The remedy for burning such sulphur is also quite obvious. If the devices for sulphur combustion are such as to agitate the surface of the burning sulphur or in any other way break this film of asphaltic material, no difficulty will be experienced. Acid manufacturers, who use mostly modern types of sulphur burners, such as the rotary or cascade type, which allow the sulphur to drop from one level to another, have absolutely no difficulty in burning sulphur containing two-tenths of one per cent. of oil, which figure represents more oil than any of the commercial sulphurs contain at the present time.

On the other hand, many of the small paper-pulp manufacturers still adhere to types of burners in which the burning sulphur is more or less quiescent. With such a type there is no agitation of the burning liquid surface, so that some of these paper-pulp manufacturers have had difficulty in burning sulphur when they happened to obtain a shipment comparatively high in oil.

Proximity of Deposits to Oil Fields

The sulphur deposits of all three operating companies are located in close proximity to oil fields. When a sulphur deposit is first opened some of the product may be high in oil, running as much as two-tenths of one per cent., but as production proceeds the oil becomes progressively lower until finally, for days at a time, it may amount to only four-hundredths of one per cent., which is totally negligible, even for burners which provide no agitation of the surface.

We have assumed that hot water carried this small quantity of oil from small crevices in the oil-sand formation to the sulphur below, when the well was first opened. After a region has become heated up by the hot water these traces of oil are pretty well washed out; consequently sulphur mined later in the same area is virtually free from it. Examination of drill cores of native sulphur showed such *in situ* sulphur to be oil free. We are informed by ex-employees of the Union Sulphur Company that this

corresponds with the experiences of that organization in heating up any new area of sulphur ground.

The examination of a very large number of samples of sulphur, representing the production of all three companies, has shown quite positively that none of their sulphur contains enough oil to cause any difficulty in its combustion with rotary burners or other burners which agitate the surface of the burning sulphur during combustion. It is only very exceptionally that one will find a car of sulphur whose oil content is high enough to make difficulties in its combustion in a stationary type of burner.

Properties and Uses of Sulphur

Sulphur is now and is likely to be for some time one of our cheapest raw materials, and accordingly should and undoubtedly will find a much wider range of usefulness. It is by studying the physical and chemical properties of a substance that one first obtains ideas as to possible new uses therefor.

Those properties which suggest certain possible tonnage uses for sulphur are its very poor conductivity of heat and electricity, its resistance to being wetted by water, and its inertness towards most acids, all of this combined with a fair degree of physical strength. These properties suggest heat insulating materials, electrical insulators of various types, water and acid-proof cements and acid-proof construction materials.

As against the properties of sulphur which might make it very desirable for certain construction purposes are certain objectionable ones, such as its brittleness and its flammability. The brittleness can be overcome sufficiently for many purposes by making mixtures of sulphur with other materials, such as sand, asbestos, or paper pulp, or by reinforcing with wire screen. In many cases the flammability is not a serious objection.

Sulphur Mixtures

A survey of the literature, especially the patents, on the subject of sulphur mixtures, reveals that almost every conceivable thing has been suggested as a perfective admixture for sulphur to obtain a material which has all the air and acid-resistant properties one could desire or to get a completely resistant kind of concrete useful in building. We have tested out most of the recipes which appeared to be promising and find as usual that the claims have been much overstated. However, the ordinary mixture of sand and sulphur which has been repeatedly mentioned in the literature has merits which deserve a wider knowledge of its properties. The mixture which has seemed to us the best for most uses is that of 40 of sulphur and 60 of sand (parts by weight). The tensile strengths of sulphur-sand mixtures as measured in the usual manner for testing cement were as follows:

Percentage of Sulphur by Weight	Tensile Strength Lbs. per Sq. In.
25	90
35	310
40	400
45	310
50	110
100	250

We have also used other fillers which have given tensile strengths of 800 and even 1,100 lbs. measured in the same manner and have to a large extent overcome the brittleness of the sulphur in some of these mixtures. Sulphur-sand briquettes kept on hand for one year show no deterioration in strength. It is evident that the 40-60 sulphur-sand mixture can be used as an acid-resistant concrete, for making acid-resisting pipe, tanks, gutters, launders, etc. The manipulation of such a mixture is much like that of pouring concrete and is as follows:

Practical Manipulation

It is evident that the sand should contain no constituent which will be attacked by any material which is to come in contact with the finished product. For instance, in the case of acid tanks, it should be free from limestone or other acid-soluble constituents. If necessary, it should be washed and dried. The sulphur may be melted in a kettle with constant stirring and

the sand, which has been heated separately, poured into it while the stirring is continued. Unless the sand is heated, it will lump when poured into the sulphur. When the material is thick enough (40 per cent. sulphur and 60 per cent. sand), it is ladled into the moulds.

Considerable flexibility is possible in handling this material. For instance, a small tank was made which was 2 ft. square, 18 in. deep, and 2 in. thick. The mixture was poured into a wooden mould in twelve different lots. Although several of these lots had solidified before the next was poured upon them, nevertheless the resulting joints were strong. Apparently the hot mixture melts sufficient of the solidified part to form a solid joint. There was no contraction of the tank as a whole and no tendency to split in the mould. This mixture can be worked with a trowel, like mortar. It can also be reinforced by wire netting placed in the mould before it is poured. The specific gravity of a sulphur-sand mixture (40 : 60) was found to be 2.46.

Weight of 1 cu. ft.	154 lb.
Weight of sulfur required per cu. ft.	62 lb.
Weight of sulfur required per cu. yd.	1670 lb.

Taking the value of sand as \$1.00 per cu. yd. and of sulphur as \$20 per ton, the price of the materials per cu. yd. will be about \$18. It may be possible to decrease appreciably the amount of sulphur necessary and hence the cost by imbedding larger pieces of crushed rock or some such substance in the mass. Tests of the material in sea water are being made but it is too early to give results. It is apparently standing up well to date.

Pipes cast of this sulphur-sand mixture show no deterioration after one year in 5 per cent. hydrochloric or 5 per cent. sulphuric acid. The ordinary organic acids have no effect on such a mixture.*

Sulphur as a Fertilizer

One possible tonnage use for sulphur which has been arousing a great deal of interest in the last two years is its application as a fertilizer. There are two methods of application which have received attention from experiment stations. During the war, when sulphuric acid was needed for munition manufacture, Lipman, of the New Jersey Experiment Station, showed that, if sulphur is composted with ground raw phosphate rock the phosphate is rendered available within a reasonably short time. Bacteria in the soil oxidize the sulphur to sulphuric acid, which acts on the raw phosphate to give available plant food. It is thus possible to make available as high a percentage of phosphoric acid as is found

*The following extract from Pulp and Paper Magazine, 17 (1920), 998, is pertinent in this connection:

The Use of Sulphur and Sand in Sewer Pipe Joints. In constructing a main line thirty-six inch sewer for the conveyance of acid waste, for a pulp mill in Quebec, the question arose as to what material should be used in pouring the joints. Cement was out of the question on account of the deteriorating effect acid would have upon it. A number of mills were corresponded with upon the subject, but no very satisfactory method was recommended.

Ultimately, the use of sulphur and sand was suggested by the Engineering Department. Lead wool was considered but rejected upon the ground that the cost was high. On the other hand, sand was available on the ground from excavations and sulphur could be purchased at the docks in Three Rivers.

The method used was as follows: An ordinary iron boiling cauldron over an open wood fire was used for heating the sulphur and sand. The proportions were one to one. The whole was heated until the sulphur melted and a semi-liquid mass formed. Three pipes were placed vertically in the trench, and by means of a galvanized conductor pipe bent at one end to fit into the flange of the pipe, the mixture was poured from a ladle on the top of the trench directly into the joint. The joints of each section of the three pipes in the trench were then poured in the ordinary manner with the use of a mortar.

The insides of the joints were pointed with wet clay. The joints cast and became solidified in about one hour after pouring. The length of time for solidification, of course, depended upon the coldness of the weather.

The joints so far have been all that could be desired, having neither blow-holes nor cracks. The solidified sulphur and sand is extremely hard and the only impression made on it with a large knife was to scrape fine particles away. In appearance it is almost metallic.

in commercial acid phosphate. The work has been confirmed by other experiment stations and would undoubtedly have been of great importance if the shortage of sulphuric acid had continued.

Lipman has since improved the procedure by isolating and growing pure cultures of the most active sulphur oxidizing bacteria, and has prepared sulphur inoculated with these. Such a product is put on the market under the name "Bac-Sul" and it is understood that the Union Sulphur Company is interested in its sale. Although we believe that a product of this kind will do all that is claimed for it, it is doubtful whether it means any immediate tonnage outlet for sulphur. Competent agricultural authorities advise that it is nearly impossible to get the American farmer to do composting and at best the introduction of any new type of fertilizer is a slow and tedious process.

Direct Application of Sulphur to the Soil

The other use of sulphur as a fertilizer consists in its direct application to the soil. The Oregon Agricultural College Experiment Station has shown very conclusively that certain soils in Southern Oregon are immensely benefited in this way, so that the alfalfa crops have been greatly increased. Several of the other State Experiment Stations have reported the same experience for certain types of soils. In fact, results obtained by the use of sulphur as a fertilizer have in some cases been so remarkable as to seriously raise the question whether some of the standard theories on fertilizers will not have to be revised.

Nearly all the experimental work through which phosphate has been given its high place as a fertilizer has been done with an acid phosphate containing considerable quantities of sulphates. Similarly, in experi-

ments with potassium and ammonium fertilizers, the sulphates have often been used. Any change in growth or yield has been ascribed to the phosphates, the potassium or the nitrogen. The question now arises as to how much of this change in plant growth was due to the sulphur entirely apart from the other fertilizing constituents.

Correspondence with virtually all the experiment stations in the United States on the subject of sulphur as a fertilizer has elicited opinions which virtually all boil down to the following: Very many of our soils either contain enough sulphur for plant requirements or receive sufficient in the rainfall and other water. There are also very many soils on which sulphur would undoubtedly prove to be an advantageous fertilizer either because of a deficiency in sulphur, or because sulphur during its oxidation would make available from the soil other needed plant foods. Work is either under way or in project in almost every experiment station in the country to obtain more knowledge on this subject, especially to find out what soils in each particular State have need of sulphur. It is probable that in time this may mean a tonnage market for sulphur, but when it is considered that there is today definite proof that the farmers of the country as a whole could use to their own profit at least ten times as much fertilizer as they do, it will be realized that the building-up of a tonnage use of any new fertilizer promises nothing large in the near future.

The greatest problem of the American sulphur industry at the present time is to obtain immediately available new tonnage outlets for sulphur. The solution of this problem would mean a continued prosperity to the sulphur industry and a continuance of low-priced sulphur for the greater chemical industry.

U. S. Fixed-Nitrogen Corporation

By a vote of 34 to 29 the Senate Bill 3390 to create the "United States Fixed-Nitrogen Corporation" was passed on January 15. It now goes to the House.

The bill creates a Government corporation with \$12,500,000 capital stock, owned by the Government and managed by a board appointed by the President, under jurisdiction of the Treasury Department. The bill requires the nitrate corporation to issue bonds up to half of the expenditures of the Government in construction of nitrate plants and for full value of hydro-electric installation at Muscle Shoals, if taken over by the corporation. The corporation is required to earn 5 per cent. interest on these securities under penalty of ceasing operation to await further action by Congress.

The property to be taken over by the corporation comprises Muscle Shoals Nitrate Plant No. 2 (Cyanamid) and Sheffield Nitrate Plant No. 1 (Modified Haber Experimental), upon which, respectively, have been spent \$68,000,000 and \$13,000,000, together with the fixed-nitrogen research laboratory at Washington, D. C., the Waco, Ala., limestone quarry and the electric power plant and transmission lines at the Warrior River station of the Alabama Power Co.

Upon the Wilson Dam have been spent about \$10,000,000, and \$40,000,000 are required for completion of the hydro-electric development; \$3,000,000 are required to equip Nitrate Plant No. 2 for ammonium sulphate production. In addition to the \$90,000,000 already expended, an aggregate of over \$110,000,000 will be called for in successive amounts to save the previous investments before the project as outlined will be complete.

The American Fibre Products Co., Hawthorne, N. J., has begun the commercial production of artificial silk filament in its plant at that place.

* * *

The Archer-Daniels Linseed Co., Minneapolis, Minn., has acquired at Edgewater, N. J., one of the last available water frontages on the west side of the Hudson River within the free lighterage limits, for the erection of an oil plant for the use of imported linseed oil for the supply of local and export markets.

* * *

The manufacture of synthetic india rubber by the Farbenfabriken, formerly Fr. Bayer & Co., in Leverkusen, Germany, has been abandoned. This step has been rendered necessary by the fact that the high prices for raw material, in conjunction with the coal shortage, make it impossible to compete with natural rubber, of which large stocks have accumulated in the world market.

* * *

The method of quoting denatured alcohol in terms of percentages is being displaced by one involving reference to formula numbers designated by the Bureau of Internal Revenue.

The formulas for denaturing alcohol are known by number. The numbers have ranged from one to six, only the last two of which are now in use. Formula No. 5 calls for the use of a certain percentage of methyl alcohol, together with benzol and pyridin base. Formula No. 6 calls for no methyl alcohol, its denaturing agents being benzol and pyridin base. The additional charge of 4c per gallon, which is noted in No. 5 is occasioned by the percentage of wood alcohol which it contains.

Summary of the Commercial Development of Chemical Engineering in Shale Oil Recovery

NAME OF PROCESS.	OWNER.	TYPE.	MATERIAL. SPECIFICATION.	METHOD OF ADVANCING SHALE THROUGH RETORT. (24 HOURS).	THROUGHPUT SHALE THROUGH RETORT. (24 HOURS).	DIMENSIONS (FEET).	FEED.	DISCHARGE.
Anderson	Anderson Shale Oil Co., Denver, Colo.	Horizontal	Iron & fire clay	Fed by screw; shale forced across floor by rotating rabble	Series of movable rabble	5 tons 16x22½ 16 ft.	Continuous	Automatic shale while hot in annealing tank and undergoes secondary distillation, 2-4 hrs.
Bishop	James A. Bishop, 12645 Lafayette St., Denver, Colo.	Horizontal	Iron & brick	Fed by screw; shale forced across floor by rotating rabble	Series of movable rabble	50-75 tons Diameter: outside, 20 ft.; inside, 16 ft.	Continuous	Automatic shale while hot in annealing tank and undergoes secondary distillation, 2-4 hrs.
Colorado Continuous	E. L. Krushnick, 421 Cooper Bldg., Denver, Colo.	Vertical	Cast iron	Helical conveyor	50 tons	Retort, 2x22; stack, 7 ft. outside diameter	Gravity	Gravity
Day	David T. Day, 715 10th St., Wash.	Horizontal	Steel	Screw conveyor	29 tons per tub.	Each tub 16 in. x 20 ft.	Continuous	Continuous
Erickson	Rainbow Petroleum Product Co., 419 Judge Bldg., Salt Lake City, Utah.	Vertical	Cast iron, common brick and firebrick.	Gravity	24 tons	Cast iron shell 20x30 ft. at top; 15 ft. long; 30x48 at bottom; 30 ft. firebrick below.	Hopper at top	Continuous
Galloupe	Galloupe Shale Process Co., 223 Chamber of Commerce Bldg., Denver, Colo.	Vertical	Cast iron entirely	Agitation	High grade, 8 tons; low grade, 40 tons per unit	Inner cyl., 16 in.; outer cyl., 24 in.; height, 18-21 ft.	Continuous	Continuous
Great Shale Oil	Great Shale Oil Co., Denver, Colo.	Horizontal	Cast iron, fire clay, brick, etc.	Rotating shovels, permitting unit application of heat to each particle	40 tons per unit	3 diam., 25 ft. long.	Continuous, adjustable	Continuous, automatic
Jenson Zone Education	J. B. Jenson, 623 McIntyre Bldg., Salt Lake City, Utah	Vertical	Special cast iron and firebrick	Conveyors and gravity	Jr. type, 10 tons per unit. Com. section type, 24 tons per unit.	Jr., 14x42x30 ft. high; Com., 26x5x32 ft. high.	Screw conveyor	Screw conveyor in water
Johns	Industrial Process Eng. Co., 508 Riado Theatre Bldg., St. Louis, Mo.	Inclined	Firebrick and cement	Scraper system	10 tons per unit.	4 ft. 4 ins. x 25 ft. long	Automatic	Gravity
Porter	John Porter and John Russell, 409 Construction details in hands of David T. Day.	Vertical	Metal and brick.	Gravity and agitation	50 tons	Retort is 12 in. across	Continuous	Continuous
Pumphreys	Construction details in hands of David T. Day.	Vertical	Steel and special fire brick	Gravity and continuous ejection of spent shale by turn-table at bottom	5 tons	15 ft. cast iron above; 20 ft. firebrick below; 4 retorts in furnace	Twice in 24 hrs.	Continuous
Randall Rotary	J. W. H. Randall, 15 E. 40th St., New York	Inclined	Steel	Gravity and speed of rotation	200 tons min.	6 x 110	Continuous	Continuous
Scott	General Education Corp., 3726 Woodward Ave., Detroit; Exchange Natl. Bank Bldg., Colorado Springs, Colo.	Vertical	Steel refractories and concrete	Gravity from hopper and magazine	20, 30 or 40 tons per 4, 6 or 8 retorts.	40-ton sizes, 12 x 22 x 50	Each 3 hrs. from through water seal into chain conveyor	Continuous
Saman Rotary	Seaman Waste Wood Chemical Co., 17 Battery Pl., New York	Horizontal	Steel shell, cast brick setting	Rotation of retort	20 tons per retort	3 ft. diam. x 30	Special air, ex. cluding seal	Special air, ex. cluding seal
Simpson	Louis Simpson, 172 O'Connor St., Ottawa, Canada	Vertical	Steel plates	Continuous movement of burden resting on two revolving rollers.	250 tons per double retort	Each double retort 8 x 5 x 33	Continuous	Conveyors to by-product plant.
Stalman Wells	Stalman (distillation) and Wells (refining), 319 Ness Bldg., Salt Lake City, Utah.	Vertical	Iron and steel	Automatically by turn-table at bottom of retort	9 tons per 4 hrs. distillation per retort	top, 1½ ft.; inside diam., 1½ ft.; bottom, 2¼ ft.; 18 ft. high	Automatic gravity in charge by turn-table at bottom of retort.	Automatic gravity in charge by turn-table at bottom of retort.
Wallace	Wallace Coke Oil and By-products Co., 412 Missouri Ave., E. St. Louis, Ill.	Vertical	Cast iron and refractories	Intermittent advocated; continuous under experimentation	48 tons	7 x 1½ x 14	Electrically operated continuous cleaning and discharging devices.	Electrically operated continuous cleaning and discharging devices.
NAME OF PROCESS.	SHAPE TREATED.	FUEL NATURE.	APPLICATION.	WITHDRAWAL OF GAS AND OIL VAPORS.	TEMPERATURE REQUIRED.	STEAM USED.	STAGE OF DEVELOPMENT.	SPECIAL FEATURES.
Anderson	20-mesh	Gas from shale	Used in gas engine to generate electricity and for distillation	First zone: 365° Under slight suction from different zones	First zone: 365° F.; last zone: 1,500 F.	None	Erected and under test	Designed, invented and patented, 1919-1920. No commercial size plant
Bishop	one inch to fines mixed	Gas from shale	Through combustion gas and oil burners	Atmospheric to 702° F.	By use of steam and far-reduced vapor pressure	Steam is generated, superheated, and charged in the retort automatically.	Low distillation temp., gradually increased to maximum, vapor quickly discharged without passage through hot zones or red hot shale. Condensates may be collected separately or in combined.....	Low distillation temp., gradually increased to maximum, vapor quickly discharged without passage through hot zones or red hot shale. Condensates may be collected separately or in combined.....

Colorado mines	Con-	Oil and gas	Air pressure blower	1,000° F.	Through outlets at different elevations to air and water-cooled condensers. Uncondensed gas sent to furnace for combustion.	No live steam admitted. Water seal in bottom of retort extremely hot zone.	Erected 1919 and under test 1920. Complete installation operated by one man. Water required is limited to 100 gal. per ton of water seal at bottom of retort.
Day		Waste gas	By burner through oven.	700° F.	As in an oil still	For ejecting shale	Designed, 1917; erected and tested, 1917-19; commercially operated, 1918-19; one-half size unit
Erickson		Gas	.....	Top of retort, 250° F. to 1,000° F. at discharge	Through perforated pipes in retort and through the shale	Used for recovery of ammonium sulphate	Have built one-half size unit
Galloupe		Oil and less residual matter through center top and outside of 1340° F. at discharge. Retort proper.	Condenser	From 212° F. at Air-cooled condensers with multiplicity of outlets for gas removal immediately after gas enters. This causes a different temperature.	Through 40 outlets spaced 4 ins. apart, with 2-in. water vacuum	None	Two units in successful operation at (1) Pragon, Utah, and (1) Dillon, Mont.
Giant Shale		Fixed gases from shale	Minus 1/4 in.	550° F. to 750° F.	Through 40 outlets spaced 4 ins. apart, with 2-in. water vacuum	None	Field size plant for demonstration of Colorado oil shale at Monticello, Utah, completed and will operate commercially on Feb. 1st-15th, 1921.
Jensen, Zone		Gas and spent shale	Lower part of furnace, contra flow upwards	From 250° F. to 900-1200° F. at discharge.	Exhauster from retort	When water is available, other wise none	Small plant in operation, 10-ton unit under construction
Johns		Spent or fresh Automatic, mix-ture, air and gas.	50-90% through 100-mesh	Outside retort 1,500° F.	Shift-movement take-off with partial vacuum	None	Designed, erected and commercially operated, 1920
Porter		Water gas from spent shale	About 1/2 in.	From 500° F. to 1,400° F.	From top of retort into condensers and scrubbers	Steam used	Designed, erected and commercially operated, 1920
Pumphreton, Scotch		Producer and oil gas and oil burners gas almost sufficient	4-6 in. to fines	750° F. in cast brick portion 1,000° F. in brick portion	Under slight suction near top	Yes, in firebrick One furnace of 1 retorts at Elko, Nev.	Most successful Scotch type shale retort in the world. All retorts in Elko, Nev. are in good shape for standard gas
Randall Retort		Gas	About 1/2 in.	Externally with suitable fire, 1000° F. in length of retort.	By partial vacuum through air water-cooled condensers	Yes, in firebrick One furnace of 1 retorts at Elko, Nev.	Crude oil obtained with minimum uncracked oil content at 1000° F. and the shale is sold for \$1.00 per ton but per dollar invested in plant. Minimum of labor. Complete installation, erected along entire length of retort. This saving in labor cost is offset by the cost of the retort and the cost of the gas.
Scott		Gas	1-1 1/2 in.	In five combustion chambers.	From retort to surface condensers to exhauster, scrubber, NH ₃ system and gas holder	Superheated, air to 100° F. pressure.	Complete recovery of all hydrocarbons and maximum recovery of N ₂ in form of ammonium sulphate, also phosphates
Soman Retort		Solid, liquid or gas	1/2 in.	or in standard design of combustion chamber.	Cast-iron pipe riser and retort head	Commercial unit for hardwood waste run successfully on shale	.....
Shannon		Fixed waste to gas	1/2 in.	Used to preheat gas and product in retort.	By exhaust through a control chamber, cooled through special by the retort gas	Plants completed for erection of 2,000 tons per steam plant	Complete recovery of by products
Shannon Wells		Gas	6 in.	By burners	Through pipes induced by fan	Yes	Commercial plant being built at Grand Valley, Ohio.
Walters		Gas	2 1/2 in. to fines	Recuperative, set-1400° F. this Standard practice.	Standard gas works control	Not advocated	Designed by Russell Eng. Co., St. Louis, and Gas Machinery Co., Cleveland, Ohio

Chemical Engineering Modesty

In the preparation of the "Summary of the Commercial Development of Chemical Engineering in Shale Oil Recovery," which appears on pages 30-31 of this issue of *CHEMICAL AGE*, a contributor informed us that "an important commercial process now in operation is omitted." Repeated solicitations to the chemical engineer responsible for the design and development of the process referred to only confirmed his original desire to have mention of his work omitted.

As an example of restraint and determination to win out on his merits, the communication of this chemical engineer is appended.

Editor, *CHEMICAL AGE*:

It is impossible for me to give any opinion on the various processes mentioned, as my attention has been so completely centered in my own conditions that I don't know much about what conditions others have to meet nor what they are doing to meet them. Being early impressed with the great variations in conditions involved, I determined to confine myself entirely to my own problems, fearing that I might get nowhere if I scattered my efforts over the whole field, and so it is proving that a little positive knowledge is worth more in my small sphere than a mass of more or less conflicting data that I might have gathered from the whole field.

I now know some things to be avoided and a few that work all right under my local conditions and with my material. I fancy one of the greatest difficulties in the way of establishing a broad industry is probably the zeal of the press in its efforts to furnish news. With no experience or knowledge of the subject to judge of them it is not strange that some grotesque stories go the rounds and the resulting disappointments and losses continue to cover the whole subject with a mass of disrepute through which honest and earnest workers must wade. And what some day is likely to be a great industry rapidly is getting to be regarded on a par with the old "gold brick industry." In spite of all, however, I find the printed statements have, at times, had their effect on me.

Last summer an officer of the Government called on me at our plant seeking data and asked to see our "process." I told him I had designed this plant for flexibility so I could study the matter under all variations of the several basic principles commonly used. Just then we were working on heating by the convection principle, but had produced several thousand gallons by direct heating and indirect heating, etc. He said he had visited every plant he could hear of and would I show him some of our oil. He figured it up, and astonished me by saying: "Do you know that there is more shale oil in those tanks than has been produced elsewhere in America all put together?" Up to that time I had unconsciously believed the papers and supposed that there were many plants making that much a week. We are gaining experience and have just started our refinery and are pressing wax. Probably we will have delays, but hope are very long to begin to market our products and be able to definitely answer questions now under study. But such answers will relate to what we know of our own conditions.

Commercial Process for Manufacturing Pure Dextrose

Dextrose or glucose is the sugar which results from a chemical treatment of cornstarch. It exists on the market as a sirup (corn sirup) or as a light brown aggregate of round solid grains having a purity of about 94 per cent. The Bureau of Standards has shown, as cited in the report of its work for 1920, that a pure white dextrose may be obtained by crystallization from a water solution and may easily be separated from the mother liquor by using a centrifugal machine. Previous methods for the preparation of the pure substance have demanded the use of alcoholic solvents.

The improved laboratory process obviously would permit of operation on a large scale and at reduced cost. A member of the bureau's staff was accordingly sent to a large glucose manufacturing company to apply the

process on a commercial scale of operation. Two processes were investigated. In the one which met with almost immediate success, the "converted" starch liquor was boiled in a vacuum until concentrated to 42° Baumé and was then dropped into a crystallizer. It was then inoculated with crystals of pure dextrose and agitated until the crystallization was complete.

The bureau has found that at a temperature in the neighborhood of 35° C. the crystalline form of dextrose changes. Below that temperature the substance contains water of crystallization; above, it is anhydrous. Consequently, it was found necessary to keep the crystal mass above 35° C. in order to prevent the formation of crystals of irregular sizes which prevent efficient work with the centrifugal machines.

When the growth was finished, the crystal mass was easily separated from the mother liquor and a satisfactory yield of pure crystalline dextrose was obtained, having the whiteness and purity of commercial cane sugar.

The second and more difficult process was that of accomplishing the crystal formation directly in the vacuum pan. While this was not brought to the same stage as the first process, enough was accomplished to show that the process was a feasible one.

In carrying this investigation to a successful conclusion, the bureau has virtually created a new industry of great magnitude. There are innumerable uses for glucose, or, as it is more commonly called, corn sugar. The fact that this material has never been available in pure form at a reasonable cost has prevented its use on a large scale.

The process developed is very similar to that used in the production of the best grades of granulated sugar, and the glucose secured by the new process is a beautiful, fine white crystal. The cost of production is actually less than the cost of producing the round, solid, brown material which was formerly produced. The magnitude of the commercial possibilities of the new sugar is shown by the fact that one of the largest corporations in the country requested the bureau to design a large scale experimental plant, costing approximately one-half million dollars. This has been done and the plant is now practically completed.

The Corn Products Refining Co., 17 Battery Place, New York, has awarded a contract to the Bedford Stone & Construction Co., Indianapolis, for the first three units of its new plant at Kansas City, Mo., estimated to cost in excess of \$5,000,000. The company's plant at Davenport, Ia., which has been idle for several years and which represented an original investment of more than a million dollars, was sold at public auction on Dec. 21 for \$155,000, in accordance with the decree of the U. S. Circuit Court of New York in dissolution proceedings for violation of the Sherman law.

The expansion of the company's foreign business has necessitated the establishment of branches in Canada and in continental Europe where in four German plants located at Halle, Steutz, Graefenhainichen and Nierstein, the company plans to manufacture many of its products for European consumption. The company also has two plants in France, one at Lille, and another near Paris. The English plant is located near Manchester.

E. C. Bedford, president of the corporation, has repeatedly emphasized that the company's business is only limited by its ability to produce, because products from corn, by reason of their food value and the fact that they are the only products capable of replacing cane and beet sugar, have met an unprecedented world demand, greater than the industry was able to supply.

Hydrogenation Freed From Patent Monopoly

Summary of the Patent Litigation of the Procter & Gamble Co. and the Berlin Mills Co.

U. S. Supreme Court Decision

THE commercial manufacture of solid from liquid fats by transforming the characteristic ingredients of liquid fats into those of solid fats by satisfying the uncombined affinities of the carbon molecule in the acid radicals of the glyceride is a chemical engineering triumph that ranks in economic importance with the recovery of glycerin from the waste lyes of soap manufacture.

In contrast, however, with the history of glycerin recovery hydrogenation has not long been the subject of exclusive control. Patent monopoly of the present process of hydrogenation based upon the researches of Sebatier and Sanderens in the use of metallic catalysts, capitulated in the first decisive contest. The contest which has resulted in declaring the right to make an edible product by hydrogenation the property of the public was instituted in the Southern District of New York in December, 1915, in the action of the Procter & Gamble Co. against the Berlin Mills Co. for infringement of the claims of the plaintiffs' patent in the manufacture of Kream Krisp.

The Berlin Mills Co. denied infringement and alleged that the patent in suit was void in view, among other considerations, of the British patent No. 1515 to Normann dated January 21, 1903, and the corresponding German patent No. 141029 of August 14, 1902. The defendant by due process subpoenaed a number of officials of the Procter & Gamble Co., including John J. Burchenal, the patentee, then vice-president and general manager; Albert E. Anderson, general superintendent; Harley J. Morrison, chemical superintendent; Wallace E. McCaw, a director and member of the executive committee, and William Cooper Procter, president of the company. This testimony disclosed that in the latter part of 1907, Edwin Cuno Kayser came to this country and disclosed to Mr. Burchenal the Normann process which had been developed in the English plant of Crossfield & Son, Ltd., and which was subsequently patented by Kayser in the United States by U. S. Letters Patent No. 1,004,035 and No. 1,008,474, which patents describe both the complete and partial hydrogenation of vegetable oils, including cottonseed oil. In addition to the testimony of these witnesses, the depositions of Clarence Von Phul and his wife were taken by the defendant, these being the people with whom Kayser lived when he first came to this country.

Consulting Chemical Talent

The trial, which began March 22, 1917, before Hon. Augustus N. Hand, District Judge, and continued over a week, attracted a large number of chemists from all parts of the country. Consulting chemical talent for the Procter & Gamble Co. comprised Dr. Charles Baskerville of the College of the City of New York and Harley J. Morrison. In behalf of the Berlin Mills Co. appeared Dr. William H. Walker, then professor of chemical engineering of the Massachusetts Institute of Technology; Dr. William D. Richardson, chief chemist for Swift & Co.; George A. Richter, of the chemical staff of the Berlin Mills Co.; Dr. Raymond F. Bacon, Dean of the School of Chemistry of the University of Pittsburgh and director of Mellon Institute of Industrial Research, and Frank E. Barrows of Pennie, Davis, Marvin & Edmonds of New York.

Fluctuations of Judicial Opinion

After the oral arguments and the filing of voluminous briefs, Judge Hand, in a decision dated October 3, 1917, reported in 250 Fed. Rep. 747, held the Burchenal patent to be invalid for lack of invention and in any event not to be infringed by the Berlin Mills Company's product, Kream Krisp.

An appeal was taken from the decision of the District Court and was heard by Judges Ward, Rogers and Hough of the Circuit Court of Appeals for the Second Circuit. In a decision dated November 13, 1918, written by Judge Hough, reported in 256 Fed. Rep. 23 (in which Judge Rogers concurred), the finding of the District Court was reversed, the Court of Appeals holding that the Burchenal patent in suit was valid and that the claims thereof were infringed by Kream Krisp. Judge Ward wrote a dissenting opinion in which he held that the District Judge was right in holding the patent void for lack of invention. In the majority decision of the Circuit Court of Appeals, the Court said in part:

"It may be assumed as true that by the mixture of cottonseed oil and animal stearin, a substance can be produced which for practical purposes is the same thing as Burchenal's chemically changed cottonseed oil; but one is a mixture and the other is not, and assuming the difference to be unimportant from the standpoint of either chemist or cook, it is a vital difference from that of the law."

A petition for rehearing was filed by the Berlin Mills Company, in which it was pointed out, among other things, that, if the patented product was so like the prior art lard substitutes manufactured by hardening cottonseed oil with oleo stearin, that the differences between them were unimportant from the standpoint of chemist or cook, then the patented product was an old product and the patent should be held to be invalid. It was pointed out that, if the product which is produced by incompletely hydrogenizing oil is substantially the same product as that produced by blending cottonseed oil and hard fat, then they are not patentably different. It was urged upon the Court that a claim for an old product could not be sustained because of the particular process by which that old product was produced.

This petition for rehearing was denied. Thereupon a petition for writ of certiorari was filed in the Supreme Court by the Berlin Mills Company, and the petition was granted. The opinion of the U. S. Supreme Court on the writ of certiorari dated December 6, 1920, and delivered by Justice Day, appears below.

Decision of U. S. Supreme Court Reversing the Circuit Court of Appeals

The patent in controversy relates to a lard-like food product consisting of a vegetable oil partially hydrogenized to a homogeneous whiteish, yellowish product. The record discloses that the making of lard substitutes has been accomplished by mixing melted fat with vegetable oils.

These oils contain glycerides—olein, linolin and stearin. The hydrogenation, or hardening process, has the effect to increase the proportion of the solid glycerides of high saturation. Stearin is called a saturated glyceride for the reason "that there are present in the molecule as many hydrogen atoms as possibly can be

joined to the carbon atoms." Linolin and olein are called unsaturated glycerides and can be converted by the addition of hydrogen into hardened glycerides.

The patentee in the specifications of his patent states the object of his alleged invention, and what he intended to accomplish, as follows:

"The special object of the invention is to provide a new food product for a shortening in cooking, in which the liability to become rancid is minimized, and in which the components of such vegetable oils which are inferior and detrimental to use as such a food product have been to a large extent converted into a higher and more wholesome form. All such vegetable oils contain glycerides of unsaturated fatty acids, and among these, notable quantities of fatty glycerides of lower saturation than olein.

"It is the presence of these glycerides of lower saturation that seriously affects the rancidity of the material. Oxidation is largely the cause of rancidity, which oxidation weakens the fat at the point of absorption at the double bonds, and these glycerides of lesser saturation readily absorb oxygen from the air at ordinary temperatures, while the more highly saturated glycerides, as olein, only absorb oxygen at elevated temperatures.

"It is evident, therefore, that oils or fats containing notable quantities of glycerides of linolic acid, or of lesser saturation, are distinctly inferior as an edible product to those containing a minimum of these glycerides with a larger per cent. of olein. On the other hand, while it is important to get rid of the readily oxidizable glycerides of lower saturation, it is also important not to supply too large a per cent. of fully saturated glycerides. . . . Oil, liquid at the ordinary temperatures, does not make the best shortening, because the oil remains liquid, keeping the food in a soggy condition, and the oil will even settle to the under part of the cooked product and oil the cloth, paper, or whatever it may come in contact with. Moreover, fats of a melting point above the temperature of the human body, 98° F., are not so digestible as fats which are liquid at this point, or which have a melting point below 98° F.

"It is, therefore, my object in the preparation of my new lard-like composition and food-product, and in preparing same from cottonseed oil, to change the chemical composition of the oil to obtain a product with a high percentage of olein, a low percentage of linolin and the lesser saturated fats, and with only sufficient stearin to make the product congeal at ordinary temperatures.

"In manufacturing this product, cottonseed or other vegetable oil is caused to chemically absorb a limited amount of hydrogen by reacting on the oil with hydrogen in the presence of a catalytic agent and at an elevated temperature. The oil is preferably agitated in a closed vessel in the presence of an atmosphere of compressed hydrogen, a catalyser of finely-divided nickel carried by kieselguhr being maintained in suspension in the oil and its temperature being raised to about 155° C.

"According to the present invention, the amount of hydrogen absorbed is carefully regulated and limited. In practice, the operation is stopped when the oil has been converted into a product which cools to a white or yellowish semi-solid more closely resembling lard than do the commercial mixtures of cottonseed oil and animal oleo-stearin, while in many respects the product is superior to the best leaf lard as a shortening. It is not so liable to become rancid and the product can be heated to a considerably higher temperature than lard without smoking or burning. . . . The high temperature to which my product can be raised without smoking or burning makes the product ideal for frying inasmuch as a crust forms almost instantly on the food fried, which prevents any absorption of the shortening.

"A lard-like product thus prepared from cottonseed oil has a saponification value of about 195; and an iodine value ranging from about 55 to about 80. The product have an iodine value of 55 has a titer of about 42° and a melting point of about 40° C.; that having an iodine value of 80 has a titer of about 35° and a melting point of about 33° C. While but partially hydrogenized, containing from about 1.5% to 2.5% of addi-

tional hydrogen more than in the nonhydrogenized material, it shows no free cottonseed oil when subjected to the Halphen test, thereby differing from all commercial lard substitutes containing this oil.

"It contains from twenty to twenty-five per cent. of fully saturated glycerides, from five to ten per cent. linolin and from sixty-five to seventy-five per cent. olein, and an average of a number of samples gives twenty-three per cent. of saturated fats, seven and five-tenths per cent. linolin and sixty-nine and five-tenths per cent. olein, while the cottonseed oil before treatment contained seventeen per cent. saturated fats, thirty-seven per cent. linolin and forty-six per cent. olein. It will thus be seen that I have produced an ideal food product, which is high in olein, low in linolin and lesser-saturated fats, and with only enough stearin to make the product congeal at ordinary temperatures."

The patent has seven claims; the two broad claims, which are the ones here involved, are:

1. "A homogeneous lard-like product consisting of an incompletely hydrogenized vegetable oil."
2. "A homogeneous lard-like food product consisting of incompletely hydrogenized cottonseed oil."

The five additional claims, more specific and limited, are not involved in this suit. Two of the four judges who considered this patent and the validity of the claims in suit reached the conclusion that they were void for want of invention; two judges of the Circuit Court of Appeals held the patent valid, and infringed.

In deciding between these conflicting views we must consider the genesis of the alleged invention, and what was theretofore known and disclosed in the art. Burchenal, the patentee, was not a chemist, and was the general manager of the Procter & Gamble Company, whose principal business had been the manufacture of soap. One Edwin C. Kayser, who had been in the employ of Crossfield & Son, an English firm, and familiar with the Normann process, to be hereinafter considered, came to this country in 1907 and saw Mr. Burchenal at the Procter & Gamble factory. A contract was made with Kayser, and an experimental plant was erected at the Procter & Gamble works for hydrogenating oil.

It is the contention of the Procter & Gamble Company that the merit of Burchenal's alleged invention arises from the fact that he was the first to originate and develop the process involved so as to make a food product of the character described.

The District Court found that Burchenal in fact invented nothing, and that all that was real invention, as established by the testimony, came from Kayser. But considering, for the purposes of this discussion, that the thought occurred to Burchenal, which he developed in the production of a food product, the subject-matter of this patent, the primary question is presented whether what Burchenal accomplished amounted to invention within the meaning and protection of the patent law.

In considering the patentability of this alleged invention, it is to be remembered that this is not claimed to be a process patent. While the process is described in the specifications, Burchenal makes no claim that it is his invention, indeed, he concedes in the testimony that the process is not his, and counsel frankly says that the patent must stand or fall upon its validity as a product patent of a new and useful thing within the meaning of the patent law. If this product were the result of mechanical improvement only, when viewed in the light of that which was previously disclosed and open to public use, the step in advance being only that which one skilled in the art might well make, without the exercise of the originating or inventing faculty, then the achievement is not within the protection of the patent law.

The English patent to Normann of October, 1903, disclosed to the world the process of converting unsaturated fatty acids, or their glycerides into saturated compounds. After referring to other discoveries he says:

"By causing acetylene, ethylene, or benzene vapour in mixture with hydrogen gas to pass over one of the said metals, the said investigators obtained from the unsaturated hydrocarbons saturated hydrocarbons, partly with simultaneous condensation.

"I have found, that it is easy to convert by this catalytic method unsaturated fatty acids into saturated acids. This may be effected by causing vapours of fatty acid together with hydrogen to pass over the catalytic metal, which is preferably distributed over a suitable support, such as pumice stone. It is sufficient, however, to expose the fat or the fatty acid in a liquid condition to the action of hydrogen and the catalytic substance.

"For instance, if fine nickel powder obtained by reduction in a current of hydrogen, is added to chemically pure oleic acid, then the latter heated over an oil bath, and a strong current of hydrogen is caused to pass through it for a sufficient length of time, the oleic acid may be completely converted into stearic acid.

"The quantity of the nickel thus added and the temperature are immaterial and will only affect the duration of the process. Apart from the formation of small quantities of nickel soap, which may be easily decomposed by dilute mineral acids, the reaction passes off without any secondary reaction taking place. The same nickel may be used repeatedly. Instead of pure oleic acid, commercial fatty acids may be treated in the same manner. The yellowish fatty acids of tallow, which melt between 44 and 48° C. and whose iodine number is 35.1, will, after hydrogenation, melt between 56.5 and 59° C., while their iodine number will be 9.8 and their color slightly lighter than before, and they will be very hard.

"The same method is applicable not only to free fatty acids, but also to their glycerides occurring in nature, that is to say, to fats and oils. Olive oil will yield a hard tallow-like mass; linseed oil and fish oil will give similar results.

"By the new method, all kinds of unsaturated fatty acids and their glycerides may be easily hydrogenized."

An expert witness, called by petitioner, gives in his testimony certain views of this process which commend themselves to our judgment as entirely reasonable and accurate, and so well stated that we quote them in part:

"Dr. Normann discovered, and sets forth in the patent, that unsaturated acids or unsaturated oils by the action of hydrogen in the presence of finely divided nickel may be converted into corresponding saturated compounds. He defines the reaction rather carefully in some regards. He says, for instance, if fine nickel powder obtained by reduction in a current of hydrogen is added to chemically pure oleic acid, then the latter heated over an oil bath and a strong current of hydrogen is caused to pass through it for a sufficient length of time, the oleic acid may be completely converted into stearic acid."

Further on he says:

"Apart from the formation of small quantities of nickel soap, which may be easily decomposed by dilute mineral acids, the reaction passes off without any secondary reaction taking place.

"I think that those two sentences which I have read very well define the product which is obtained by such reduction especially the second sentence, where he says that the reaction goes on in a quantitative way, we will say; that is he says that there is no side reaction takes place. A chemist would know from this first paragraph where he says that oleic acid goes to stearic acid, and from the second one where he says that no side reaction takes place, the chemist would know exactly what the product is which is formed by this reaction.

"I would call attention particularly to the fact that he hardened olive oil to a hard, tallow-like mass. Tallow is a substance that is obtained from the fat of either cattle or of sheep and is a substance of somewhat semi-solid character; that is, its lower limit of

melting point is within a lard range and its upper limit is just slightly beyond the lard range so that if Normann hardened olive oil to a tallow-like mass that means that he hardened it to a product of a semi-solid character.

"Q63. Does Normann specify anywhere in his patent any of the purposes for which his patents are intended? A. He does not. He says nothing in the patent as to what these products should be used for. The presumption is that they might be used for any purpose for which fats of that general character could be utilized. They might be used for making candles; they might be used for soaps; they might be used for edible purposes.

"By the passages I have read he has very carefully specified what the product is so that any chemist would know for what particular purposes it might be useful.

"Q64. In the process of hydrogenation as described in the Normann patent from which you made citations; that is, the British patent No. 1515 of 1903, what would your conclusion be as to the edibility of the resultant product when the material hydrogenated was among those suggested by him, olive oil? A. If an edible olive oil was started with one would certainly obtain an edible hydrogenated product."

It is in evidence that this method, shown by Normann, is a practicable one, and may be used for the making of edible food products of the kind here involved.

With the knowledge disclosed in the Norman patent conclusively presumed to be known by the patentee, was it invention to apply the known process to vegetable oils? In this connection the history of the application for the patent in suit in the Patent Office is interesting and instructive. It is true that claims one and two were finally allowed, and the patentee is entitled to the presumption which arises from the granting of them. But it appears in the history of the application for the Burchenal patent, found in the record, that as originally presented it contained two claims not so broad as the ones now in suit, and a third claim for "A semi-solid hydrogenized oil," was added by amendment. All of the claims were rejected, the Examiner saying:

"The composition of lard and of cottonseed oil as to the glycerides olein and stearin that they contain is well known. To make a product from cottonseed oil that shall simulate lard the content of stearin should be increased. (Referring to patents.) It is thought, therefore, that if the problem of simulating lard from cottonseed oil were presented to an oil chemist, an incomplete hydrogenization of the cottonseed oil would at once suggest itself to him as a solution of the problem. All the claims are accordingly rejected on the above ground of lack of invention. Claim 3 is further rejected on the product formed by the above cited patents."

Replying to the communication of the examiner amendment was made canceling claim 3. Further consideration was requested on claims 1 and 2, upon arguments which were presented. The claims were afterwards rejected upon reference to patents to Kayser of September 26, 1911, and November 14, 1911. The examiner stating that these patents were adapted to hydrogenize glycerides, the latter one specifically mentioning its adaptability for cottonseed oil, and that the process could be arrested at any time during the progress and thus an incompletely hydrogenized article be produced.

Subsequently the specifications were amended, giving more definitely the percentages of olein, linolin and stearin. The patentee concludes the amended specifications, stating "It will thus be seen that I have produced an ideal food product, which is high in olein, low in linolin and lesser-saturated fats, and with only enough stearin to make the product congeal at ordinary temperatures"; additional and more limited claims were added, but ultimately the patent, containing the broad claims here involved, was granted.

It is true, as the Circuit Court of Appeals states in its opinion, that the applicant never did acquiesce in the examiner's action rejecting his claims, and finally obtained what he had in the first place asked for.

This record establishes that it was known before Burchenal took up the subject that a vegetable oil could be changed into a semi-solid, homogeneous, substance by a process of hydrogenation arrested before completion and that it might be edible. This much of the art was public property and open to general use. The product of this process was known and open to public use. To supply such products as the patentee has described in the broad claims in suit may have been new and useful, but does not in our opinion arise to the dignity of invention, and is an advance step which would occur to one skilled in the art when investigating and considering the subject. It follows that the decree of the

Circuit Court of Appeals must be reversed and the cause remanded to the District Court with directions to dismiss the bill on the ground that claims 1 and 2 are void for the reasons stated in this opinion.

Legal Talent

Counsel for the Berlin Mills Company included Marcus B. May, Esq., of Boston; John C. Pennie, Esq., of New York; Hon. Charles E. Hughes, of New York, and Melville Church, Esq., of Washington. Counsel for Procter & Gamble Company included Livingston Gifford, Esq., of New York; Alfred M. Allen, Esq., of Cincinnati; John H. Brickenstein, Esq., of Washington, and the late Mr. Thomas B. Kerr, of New York. The arguments in the Supreme Court were conducted by Mr. Marcus B. May and Hon. Charles E. Hughes for the Berlin Mills Company, and by Mr. Livingston Gifford for the Procter & Gamble Company.

New Jersey Chemical Society

The regular monthly meeting of the New Jersey Chemical Society at Stetter's restaurant in Newark on the 10th inst., after the well-attended informal dinner, was addressed by Dr. Milton C. Whitaker, vice president of the U. S. Industrial Alcohol Co. and by C. O. Chan, of the China Commercial Co., Ltd., 2 Rector St., New York.

Dr. Whitaker discussed chemical organization and management in an intimate, convincing and comprehensive way that could be done only by one who has been "through the mill." The handling of help; the adjustment or men of various capacities into work in the organization for which they are best qualified; the elimination of misfits for the good of the service; the ridicule of industrial democracy in work that demands for the salvation of the organization the free play of natural law; the value of tact, character, know-how and determination; the general ineffectiveness of "committeitis" to produce results whether in a technical society or in a plant run for profit; the adaptation of disciplinary instruments to varying degrees of intelligence; the importance of team-work; the desirability of giving men more than they can do that morale may not suffer from the introspection of leisure on the company's time—all these and many other aspects of management and men as relate to the work of production were discussed frankly with men who make their living in chemical plants.

Dr. Whitaker gave a notable talk with honor to himself and to the society.

C. O. Chan, a graduate of the Canton Christian College and engaged in the Oriental trade in New York described present social, economic and political conditions in China introductory to a description of Chinese resources and products used in the chemical trade. Mr. Chan himself was his one best exhibit. His fluent and scholarly command of English, an acquirement of ten years, prompted Dr. Crane to laudatory comment on the beneficence of English civilization as a Chinese import.

The illimitable resources of China in the elements of material civilization suggested that the western course of empire leads to China. Low per capita productivity, the cheapness of man-power and lack of transportation stunt the development of vast regions fabulously endowed with useful things.

The enterprise of the Membership Committee was expressed in the addition of 32 members, bringing the total membership of the society to a figure approaching 600.

Lever Bros., Ltd., Absorb American Linseed Company

The increase in the authorized capitalization of Lever Bros. Co., a Maine corporation, of Boston, Mass., from \$12,000,000 to \$150,000,000, indicates the approaching consummation of the absorption of the American Linseed Co. into Lever Bros., Ltd., the largest British industrial corporation, through the medium of its American branch.

The expansion of Lever Bros., Ltd., from an exclusively soap manufacturing enterprise into the largest concern in the world devoted to detergents, to food products derived from vegetable fats and oils and to the basic raw materials, is one of the marvels of a recent era of industrial consolidation in Great Britain, and reflects the rapid growth in industrial importance of vegetable glycerides coincident with the relative and absolute diminution of animal sources of supply.

The American Linseed Co., the largest individual stockholder of which is John D. Rockefeller, Jr., was incorporated in 1898 to consolidate a number of independent mills with those of the National Linseed Oil Co. It was estimated at the time that the combined properties represented about 85 per cent. of the linseed production of the United States. The present active plants comprise: Dean Linseed Oil Works, Port Richmond, S. I., New York; Grove Linseed Oil Works, Philadelphia, Pa.; Kellogg & McDougall Works, Buffalo, N. Y.; Northwestern Linseed Oil Works, St. Paul, Minn.; Pacific Oil & Lead Works, San Francisco, Calif.; Portland Linseed Oil Works, Portland, Ore.; Sioux City Linseed Oil Works, Sioux City, Ia.; Wright & Hills Linseed Oil Works, Chicago, Ill.

In 1917, the American Linseed Co. acquired for \$1,332,000, the Nuco Butter Co., refiners of nut oils and manufacturers of margarine. The growth of the artificial butter business has been so rapid as relatively to reduce the importance of the linseed oil end of its activities.

The American Linseed Co. has outstanding 167,200 shares of preferred stock of a par value of \$100 a share and an equal amount of common stock, also of a par value of \$100, making a total outstanding capital of \$37,445,000.

Wallace & Tiernan & Co., Inc., 349 Broadway, N. Y., manufacturers of chlorine control equipment, has acquired the former plant and site of the Klaxon Co., in Newark, N. J., and will take possession January 1, utilizing premises for its manufacturing purposes.

Potassium Ferrocyanide from Coal Gas Residues

By G. Grube and B. Dulk

IMPURITIES in crude coal gas comprise hydrogen sulphide, ammonia, cyanogen and organic sulphur.

In the purification of the gas by exposing it in contact with some form of iron oxide, the resultant mass of spent purifying material is of complex composition whose chief ingredients are free sulphur, often approximating 50 per cent., ammonia in the form of thiocyanate or sulphate and Berlin or Prussian Blue, known chemically as ferric ferrocyanide, with the composition indicated by the formula $\text{Fe}_4[\text{Fe}(\text{CN})_6]_3 \cdot 10\text{H}_2\text{O}$. This spent residue of coal gas purification is the raw material for the manufacture of potassium ferrocyanide.*

Numerous methods have been practiced for the recovery of the compounds mentioned. As regards the ferrocyanide ingredient they may be classified according to the acid or alkaline character of the reaction as acid and alkali processes.

Acid Process

The acid process consists in treating the raw material with different acids, whereby iron oxide and ammonia are dissolved, and the remainder, which contains principally sulphur and Prussian blue, is processed to obtain the ferrocyanide or the pure pigment.

Harcourt describes¹ a process in which sulphuric acid is used to effect the solution of iron oxide and ammonia. The residue of sulphur and Prussian blue, on treatment with ammoniacal liquor, yields a solution of ammonium ferrocyanide which is transformed into potassium ferrocyanide, the blue pigment. Carbon bisulphide has been used in solvent extraction of the sulphur.²

The large quantity of acid required results to the great disadvantage of the acid process. So little is known of the technical details of the acid process, it must be concluded that its usefulness is limited.

Alkali Process

Potassium ferrocyanide is made on a large scale by the alkali process. At first caustic soda was used, but this expensive reagent was replaced soon by hydrated lime. In this process, after the soluble salts have been removed by leaching with water and the sulphur by extraction with carbon bisulphide, the residue is treated with hydrated lime at 40° to 100° C. A difficultly soluble salt, $\text{CaK}_2\text{Fe}(\text{CN})_6$, is obtained which then is converted into the potassium salt by heating with potash solution, in accordance with this reaction: $\text{CaK}_2\text{Fe}(\text{CN})_6 + \text{K}_2\text{CO}_3 = \text{K}_4\text{Fe}(\text{CN})_6 + \text{CaCO}_3$

Direct Treatment with Lime

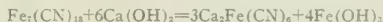
The sulphur extraction is omitted in this case and the leached mass is treated directly with lime. It is generally advisable to allow this mass to dry to some extent in the air and then to incorporate dry powdered hydrated lime with it and extract the mixture with water. The mixture is made by first turning over the lime and the gas purification residues with a shovel and then passing the mixture through disintegrators and over shaking-screens. The finely grained product thus obtained, on standing in heaps, generates suffi-

cient heat to effect partial decomposition of the ferric ferrocyanide.

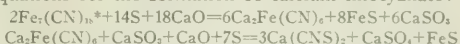
After exposure in piles for 12 hours, the mass is placed in rectangular boxes provided with a suitable filtering medium. Five to ten of these batteries form a lixiviation battery. Water flowing counter currently extracts calcium ferrocyanide, $\text{Ca}_2\text{Fe}(\text{CN})_6$. Ammonia present in the solution is recovered by distillation. By treatment with K_2CO_3 , in accordance with the above equation, $\text{K}_4\text{Fe}(\text{CN})_6$ is obtained.

Chemistry of the Lime Conversion

Decomposition of gas purification residues by means of lime requires considerable operating experience and exact understanding of conditions to obtain a satisfactory yield of ferrocyanide. The chief reaction of the process is:



In addition is the action of sulphur and lime on Berlin blue which results in the formation of calcium thiocyanate, $\text{Ca}(\text{CNS})_2$. Höbbling writes the following equations for the formation of calcium thiocyanate:



Both reactions ensue more readily with rise of temperature. Therefore, it is necessary to conduct the process at such temperature that the soluble ferrocyanide is formed directly from the Prussian blue; otherwise the yield will be poor as considerable Prussian blue will be converted into thiocyanate and lost. The most suitable temperature lies between 50-60° C. However, complete conversion of the Prussian blue into soluble calcium ferrocyanide does not result even when the process is carried out according to the best technical practice. As a rule the residue after lixiviation contains 1-2 per cent of insoluble ferrocyanide. Also the proportion of undecomposed ferrocyanide is independent of the Prussian blue content of the original raw material.

Hence, when it is assumed that the content of the leached mass in insoluble ferrocyanide is 1.5 per cent., it is evident that when the total ferrocyanide percentage is 5 per cent, the yield can be only 70 per cent., and when it is 10 per cent, the maximum yield can be 85 per cent.

Character of the Lixivated Residue

Microscopic examination shows that particles of unchanged Prussian blue can no longer be detected in the leached residues, containing 1 to 2 per cent. of insoluble ferrocyanide. After this mass has been reduced to fine powder, it has a uniform grayish-blue color. Consequently, it is very likely that the ferrocyanide, remaining in the lixiviated material, does not exist there in the form of Prussian blue, but as another insoluble ferrocyanide compound. This supposition is supported by the behavior of the residues. If they are permitted to lie exposed to the air for a long time, the top surface becomes bluish in color and after a long time soluble ferrocyanide can be found in the mass. The insoluble ferrocyanide has been converted in part into the soluble form by the action of the air. The importance of this action in the recovered by-products from the purification of coal gas has not

*Zeitschrift für angew. Chemie 1920, I, pp. 141-144.

¹Tour. für Gasbel. 1895, 678.

²Wolfrum process. German patent No. 46215

*Another method of writing the formula of Prussian Blue: $\text{Fe}_4[\text{Fe}(\text{CN})_6]_3$

been realized up to the present time. The purpose of the research, whose results are described herewith, is to investigate this phenomenon experimentally.

Method of Working and

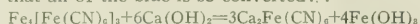
Arrangement of Experiments

The analysis of the residues recovered from gas purification used in these experiments is as follows:

Ferrocyanide*	7.8 %	$K_4Fe(CN)_6 + 3H_2O$
Thiocyanate	0.25%	NH_4CNS
Soluble Ammonia	0.71%	NH_3
Total Ammonia	1.7 %	NH_3
Water	26.3 %	H_2O
Sulphur	34.34%	S

The hydrated lime, used in the tests, contained 96.42 per cent CaO and 2.01 per cent. $CaCO_3$.

The conversion of the Prussian blue, contained in this mixture, into calcium ferrocyanide by the action of slaked lime is shown in the following equation, assuming that all of the blue is so converted: :



According to this equation, the theoretical consumption of slaked lime for a total ferrocyanide content of 7.8 per cent. in the original mixture is 2.74 parts for every 100 parts of the mixture.

The experiments have been made in such a manner that the results can be applied directly to actual practice. A thorough mixture of the gas purification residues and the slaked lime is made by grinding the two in a mortar. Then, after the mixture has been heated for a long time at a certain definite temperature in a corked flask, it is leached with water and the ferrocyanide content of the solution is determined. The Feld method of analysis is used.†

Influence of the Quality of Slaked Lime Used on the Yield of Ferrocyanide

A series of three tests were made using in each 50 parts (grams) of the gas residues with varying quantities of slaked lime. Forty grams of the mixture and enough water to make a combined volume of 500 ccm. were heated to 50° C. for 12 hours. The ferrocyanide content of the solutions were then determined and calculated on the basis of $K_4Fe(CN)_6 + 3H_2O$. The results of the experiments are given below in Table I.

TABLE I (in Grams)

Test No.	Composition of Mixture—		Quantity of Gas Slaked Lime Used	Corresponding $K_4Fe(CN)_6 + 3H_2O$ Content		Yield %
	Residues	Lime		In Solution	$K_4Fe(CN)_6 + 3H_2O$	
1.....	50	3	40	2.831	0.630	22.3
2.....	50	5	40	2.728	1.091	40.0
3.....	50	10	40	2.597	1.097	42.3

The yield, shown in the above table, is not the total yield of ferrocyanide that would be obtained by a systematic repeated leaching process, but the yield resulting from a single extraction with water only. The results, recorded in the first three tables, are of this nature, it being assumed that the total yield varies with the different conditions of the tests in a corresponding manner as the partial yield.

It is seen from the above table that the yield increases with the slaked lime content of the mixture. As has been mentioned above, in actual practice the mixture of lime and gas residues is allowed to lie in piles for quite a long time before lixiviation takes place with a resulting partial decomposition of the Prussian

blue. The next series of experiments were made in accordance with actual operating conditions. The mixture is placed in a stoppered flask and kept at 40-50° C. in a drying oven, then digested with water for about 10 hours at room temperature. The results are given in Table II.

TABLE II (in Grams)

Test No.	Temp. ° C.	Composition of Mixture—		Quantity of Gas Slaked Lime Used	Corresponding $K_4Fe(CN)_6 + 3H_2O$ Content	$K_4Fe(CN)_6$ in Solution	Yield in %
		Residues	Lime				
4..	50	50	1	40	2.830	0.119	4.2
5..	50	50	3	40	2.722	1.133	41.6
6..	50	50	5	40	2.620	1.377	52.6
7..	50	50	10	40	2.404	1.190	49.5
8..	50	50	15	40	2.217	0.984	44.4
9..	50	50	20	40	2.063	0.818	39.7
10..	40	50	3	40	2.722	1.304	47.9
11..	40	50	5	40	2.620	1.323	50.5
12..	40	50	10	40	2.404	0.935	38.9

It may be mentioned immediately that the results, shown in Table II, bear out our predictions. Comparing tests 5 to 7 with 1 to 3, it is seen that a considerable increase in the yield results under the conditions of Table II. The significance of this fact is that the decomposition of the Prussian blue by lime is a slow process. This action commences at the very outset in the freshly prepared mixture, which always contains water in addition to the other constituents. Another very important conclusion can be derived from the results in Table II, viz., that the yield does not increase indefinitely with the quantity of lime used for the conversion, but that as the lime content of the mixture increases, the yield reaches a maximum and then decreases again. The maximum content of slaked lime is 10 per cent. If more is used, a lower yield of ferrocyanide is obtained.

Influence of Temperature on the Yield

Besides the lime content of the mixture, the temperature at which conversion takes place also is of importance. As has been mentioned above, in addition to the decomposition of the Prussian blue with the formation of a soluble calcium ferrocyanide, another reaction between the Prussian blue, lime and sulphur takes place and results in the formation of thiocyanate. This latter action is promoted by an increase in temperature. For this reason, it is very essential to employ the most favorable temperature in the conversion process, namely, that one which will give the best yield of ferrocyanide with the minimum conversion into thiocyanate. Table III shows the results obtained by varying the temperature, using a lime content of 10 per cent.

TABLE III (in Grams)

Test No.	Temperature of Conversion in ° C.	% Yield of Total Ferrocyanide as $Ca_2Fe(CN)_6$
13.....	30	39.4
14.....	40	50.5
15.....	50	53.6
16.....	65	47.4
17.....	75	43.5
18.....	80	30.5

It is seen very readily that the best temperature is 50° C. Between 50 and 70° C., the yield decreases slowly and between 70 and 80° C. quite rapidly. The decomposition process should not take place above 60° C., otherwise, considerable thiocyanate will be formed; neither should the temperature fall much below 50° C., as then the speed of the decomposition reaction is so slow that commercially satisfactory yields cannot be obtained.

The yields shown in Tables I, II and III are com-

*Represents total ferrocyanide as $K_4Fe(CN)_6 + 3H_2O$.

†Jour. für Gasbel. 1903, 553.

parative figures, as they do not indicate what can be obtained by a systematic repeated leaching operation. For example, if 160 grams of a mixture containing 10 per cent. slaked lime is subjected to repeated leachings with 4 liters of water at 50° C., a total of 9.2 grams of soluble ferrocyanide can be obtained. As the original mixture contained 10.91 grams of ferrocyanide (7.4%), the yield was 84.3 per cent. There was left in the washed residues 1.2 per cent. of insoluble ferrocyanide.

The results, which we obtained in these experiments, have been confirmed by actual plant operations. An excess of lime is used generally. A new fact of great importance technically is that this excess cannot be too large without seriously impairing the yield. The low yield is not due to incomplete decomposition of the Prussian blue. A by-reaction must take place, one which has been unknown hitherto and which converts a part of the ferrocyanide into the insoluble state once again. Our purpose is to study this by-reaction in greater detail.

Concerning an Insoluble Compound Between Ferric Hydroxide, Calcium Hydroxide and Calcium Ferrocyanide

In studying this problem, the following method of reasoning was used:

- (1) An insoluble ferrocyanide compound could be formed only by the combination of the soluble calcium ferrocyanide with the other constituents of the solution.
- (2) These constituents are ferric hydroxide, $\text{Fe}(\text{OH})_3$, calcium hydroxide, $\text{Ca}(\text{OH})_2$, and sulphur.
- (3) A solution of chemically pure calcium ferrocyanide, when treated with freshly precipitated washed ferric hydroxide, remains unchanged when heated for a long time.
- (4) A reaction takes place when the ferrocyanide solution is treated with slaked lime.
- (5) A reaction takes place when ferric hydroxide and slaked lime are added simultaneously to the ferrocyanide solution.

Experimental Details

A 500 ccm. flask, provided with a good stirring arrangement, is half filled with milk of lime, and to it a solution of ferric chloride (FeCl_3), is added with constant stirring. A brown precipitate of $\text{Fe}(\text{OH})_3$ is formed. The entire contents of the flask are kept in vigorous agitation, while an excess of a solution of calcium ferrocyanide is added. After one hour's constant stirring, the color of the precipitate changes gradually from brown to white. An analysis of the solution shows a considerable decrease in the quantity of ferrocyanide. An insoluble compound between ferric hydroxide and calcium ferrocyanide has been formed in an alkaline solution. The results of a series of experiments, in which the quantity of FeCl_3 used varies, are given in Table IV.

TABLE IV (in Grams)

Test No.	Ca-Fe-CN ₆ in Solution	FeCl ₃ Added	After Addition of FeCl ₃ to Ca-Fe-CN ₆ Content of Precipitate of Solution		
			Ca-Fe-CN ₆ of Precipitate	FeCl ₃ of Solution	In Concentration %
19....	1.924	0.335	0.288	1.636	15.0
20....	1.924	1.005	0.693	1.231	36.0
21....	1.924	1.775	1.234	0.690	64.1
22....	1.924	2.512	1.557	0.367	80.0
23....	1.924	2.845	1.924	0.000	100.0

It is evident that all of the soluble $\text{Ca}_2\text{Fe}(\text{CN})_6$ can be converted into the insoluble complex by the use of sufficient ferric chloride.

It was found that the insoluble compound was stable

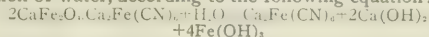
only in the presence of calcium hydroxide. After considerable difficulty the following formula was established for this double salt: $2\text{CaFe}_2\text{O}_4 \cdot \text{Ca}_2\text{Fe}(\text{CN})_6 \cdot x\text{H}_2\text{O}$.

Further Experiments Relative to the Complete Decomposition of Gas Purification Residues

There is no doubt at all that the formation of the new compound is responsible for the low yield of ferrocyanide in the slaked lime process of treating gas residues. Consequently, all influences which tend to destroy this complex salt will be reflected in a higher yield of ferrocyanide.

Decomposition by Hydrolysis

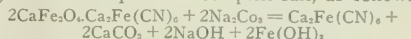
The complex salt is decomposed by the hydrolytic action of water, according to the following equation:



While the reaction is a very simple one, theoretically, it is not possible practically. It can be shown very readily that the action of water is very slow at high temperatures. Then again, large quantities of water must be used, because $\text{Ca}(\text{OH})_2$ is so insoluble. The very dilute solutions, which would be obtained in this way, are impracticable technically, because in the first place the solutions are too dilute to permit the formation of the double salt, $\text{CaK}_2\text{Fe}(\text{CN})_6$, in a later stage of the process and in the second place because the concentration of the solutions to make them usable is too costly an operation for practical purposes.

Other Methods of Decomposition

It is well known that the use of soda in addition to lime results in very good yields. The action of the carbonate of soda (carbon dioxide has the same effect) is to decompose the complex salt, as follows:



Hydrogen sulphide, calcium sulphide and other similar sulphur compounds have been used for this purpose. The reducing action of the sulphur compounds converts the ferric compounds into the ferro compounds and increases the yield thereby. By the use of hydrogen sulphide (H_2S), a total yield of 98.5% is obtained. The process consists in treating the washed residues, after the soluble ferrocyanide has been extracted with water, with water at 75° C. and passing H_2S through the mixture. The filtered solution is added to the leachings obtained in the first part of the process.

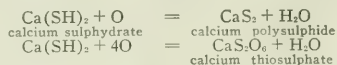
Oxidizing agents, such as pyrolusite (MnO_2) and Weldon mud* have been used to increase the ferrocyanide yield. A yield of 97.3% was obtained when the washed residues were treated with pyrolusite, with constant air agitation.

It is very evident that the effect of the sulphureted hydrogen is to convert $\text{Fe}(\text{OH})_3$ into ferrous sulphide, FeS , destroying its deleterious action on the yield. The action of the pyrolusite is not so obvious. It was thought at first that the pyrolusite acted directly on the insoluble double salt to form a calcium manganate. Accordingly, the double salt, $2\text{CaFe}_2\text{O}_4 \cdot \text{Ca}_2\text{Fe}(\text{CN})_6$, was suspended in water and treated with MnO_2 for a long time with constant heating. No decomposition took place. The mechanism of the reaction is of an entirely different sort.

*In the Weldon process of making chlorine by the action of hydrochloric acid or pyrolusite the manganese mud is recovered and treated to form the oxide. This material is known as "Weldon Mud." It contains Mn_2O_3 mainly.

Actual experience in the plant has demonstrated the fact that when the leached residues, containing the complex salt, $2\text{CaFe}_2\text{O}_4 \cdot \text{Ca}_2\text{Fe}(\text{CN})_6$, are permitted to lie exposed to the air, the greater part of the ferrocyanide is changed back again into the soluble form. To increase the yield of ferrocyanide, it is evident that either the complex salt must be broken down after it is formed or better still its formation must be prevented by removing one or more of the responsible inter-reacting substances.

In explaining the destructive action of the air on the ferrite of calcium complex, it may be thought that the principal part is played by the carbon dioxide in the air. This is not so. The oxygen in the air is the much more potent factor. Besides the double ferrocyanide the washed residues contain some excess slaked lime, free sulphur and some calcium sulphide and calcium sulphhydrate, $\text{Ca}(\text{HS})_2$. The action of the moist air on the latter salt is similar to that in the Schaffner-Mond process, used to regenerate the waste liquors in soda manufacture, and results in the formation of calcium polysulphide and calcium thiosulphate, as follows:



The polysulphide converts the ferric hydroxide into ferrous sulphide, acting just like sulphuretted hydrogen.

As is now evident, it is altogether unnecessary to add any sulphur compounds to effect this conversion. All that is required is to blow air through the mass containing the double ferrocyanide, to cause its decomposition. The temperature at which the action takes place is very important and its effect on the ultimate yield of ferrocyanide was investigated in a series of experiments.

After the gas purification residues had been washed four successive times, the washed mass was mixed with water and air was blown through the mixture at a constant temperature for 9 to 10 hours. The results are given in Table V.

TABLE V.

Test No.	Temp. at which action takes place	Mixture used	Corresponding $\text{Ca}_2\text{Fe}(\text{CN})_6$	$\text{Ca}_2\text{Fe}(\text{CN})_6$ in solution—			Total	%
				Four combined leachings	Air blowing process yield			
24	50°C	40	2.830	1.980	0.478		2.458	86.8
25	75°C	40	2.830	1.980	0.669		2.649	93.6
26	80°C	40	2.750	1.911	0.689		2.600	94.7
27	85°C	40	2.750	1.911	0.709		2.620	95.3

The results, shown in Table V, indicate that the best yield obtained with the air blowing process at 80 to 85°C., is almost equal to that obtained in the sulphuretted hydrogen process. The air process is simpler and cheaper than the other processes. The new process has been used in Germany on a large scale and the actual operating results corresponded very closely to those shown in Table V.

Conclusions

I. The yield of ferrocyanide from gas purification residues increases with the quantity of lime used up to a certain maximum, beyond which a further increase in the amount of lime incorporated in the mixture results in a decrease in the yield.

II. The unfavorable action of the excess lime is due to the formation of the difficultly soluble salt, $2\text{CaFe}_2\text{O}_4 \cdot \text{Ca}_2\text{Fe}(\text{CN})_6 \cdot x\text{H}_2\text{O}$.

III. There is an optimum temperature at which the greatest yield of ferrocyanide is obtained. As the temperature increases beyond this point, the formation

of calcium sulphocyanide from the Prussian blue contained in the gas purification residues is promoted with a corresponding lowering of the ferrocyanide yield.

IV. Even when operating under the most favorable circumstances, with the proper lime content and at the optimum temperature, the double salt, $2\text{CaFe}_2\text{O}_4 \cdot \text{Ca}_2\text{Fe}(\text{CN})_6 \cdot x\text{H}_2\text{O}$, will form. This explains the fact that the leached residues always contain 1 to 2% of insoluble ferrocyanide.

V. The principle on which the sulphuretted hydrogen and other similar processes operate is that the sulphur compounds decompose the double ferrocyanide by converting $\text{Fe}(\text{OH})_3$ into FeS .

VI. The new process consists in treating the leached material in the presence of water at high temperatures by blowing air through the mass. The oxygen in the air converts the sulphhydrate contained in the mixture to a polysulphide which reacts with $\text{Fe}(\text{OH})_3$ to give FeS . The double salt is decomposed in this way. The soluble ferrocyanide is formed and the yield is increased.

Beet Sugar in Colorado

The production in 1920 of 670,000,000 pounds of sugar by 18 factories from 2,750,000 tons of beets grown on 250,000 acres, is the culmination of a growth dating from 1901 when a single plant at Loveland, Colo., treated the crop of 5,600 acres. The value of the 1920 crop, estimated at 8c a pound, is \$53,600,000, as compared with \$43,000,000 for the 1919 crop of 537,500 pounds.

The Great Western Sugar Company has factories operating at Greeley, Loveland, Longmont, Fort Collins, Brighton, Brush, Fort Morgan, Sterling, Eaton and Windsor. A new factory at Johnstown will grind beets in the fall of 1921 if the price of sugar goes up to the point where it will be profitable and safe to continue the building programme. On December 15, with sugar slumping to the 8c mark, the company announced that further work would be discontinued on the Johnstown plant and on the other \$2,000,000 factory which was under construction at Minatare, Neb. At Johnstown the steel is up for a 1,200-ton plant; the company also is building there a great sugar warehouse.

The Dupont Sugar Corporation, in which Denver and Pacific coast capital is interested, has purchased a factory site at Wellington, north of Fort Collins. The Industrial Sugar Company will operate its second mill next fall.

The American Beet Sugar Company has factories at Rocky Ford, Lamar and Las Animas; the Holly Sugar Corporation at Grand Junction, Swink, and a new one at Delta; the National Company at Sugar City and the Industrial Sugar Company at Fort Lupton. The Industrial Sugar Company, owned largely by growers, completed a 600-ton plant during the year at Fort Lupton and its output totaled 40,000 bags.

The H. W. Johns-Manville Co., Madison Avenue and Forty-first Street, New York, will soon commence the installation of machinery at its limestone properties at Plymouth Meeting, Pa.

* * *

The Emerson Apparatus Co., manufacturers of industrial laboratory equipment, formerly at 251 Causeway Street, Boston, Mass., are now located at 171 Tremont Street, Melrose, Mass.

Personal Items

George H. Kimber has left the United States Color & Chemical Company, Ashland, Mass., and is now with the Semet-Solvay Company, Syracuse, N. Y.

* * *

Chas. Zeller is now chemist for the Abner Royce Co., Cleveland, O. He was formerly salesman for W. J. Bush & Co., Inc., New York, in the Detroit section.

* * *

G. N. Prentiss has been appointed engineer of tests of the Chicago, Milwaukee and St. Paul Railway Co., with headquarters at Milwaukee, Wis.

* * *

Dr. Edgar Fahs Smith, formerly Provost of the University of Pennsylvania, has been elected president of the American Chemical Society.

* * *

Charles H. MacDowell, president of the Armour Fertilizer Works, has been elected a member of the board of directors of the Garfield National Bank of New York.

* * *

W. H. Chamberlain of the Hooker Electrochemical Co., New York, sailed for Europe during the latter part of December on a business mission that will keep him abroad for three or four months.

* * *

Arthur A. Lehmann, formerly with Katzenbach & Bullock Co., 440 Washington St., New York, is now in charge of the chemical department of S. Wander & Sons Chemical Co., 501 Fifth Avenue, New York.

* * *

Charles A. Fort, formerly research chemist on insulation at the Pittsfield, Mass., plant of the General Electric Co., is now chief chemist of the Forest Products Chemical Co., Memphis, Tenn.

* * *

Charles A. Edwards, for many years manager of the Portland, Ore., office of A. O. Anderson & Co., has severed that connection to become head of the Portland Vegetable Oil Milling Company, Portland.

* * *

Andrew M. Fairlie, sulphuric acid engineer of Atlanta, Ga., has been retained by the Baugh Chemical Company as consultant in connection with the maintenance and economical operation of their sulphuric acid plants at Baltimore.

* * *

Lindsley Loring, for many years chief executive of the Cochran Chemical Co., Everett, Mass., and since its absorption in 1916 by the Merrimac Chemical Co., a vice-president and director of the latter company, has resigned from these positions.

* * *

Dr. J. F. Carle, until recently chief chemist at United States Nitrate Plant No. 2, Muscle Shoals, Ala., has resigned from the Nitrate Division to become president of the Southern Testing Laboratories at Birmingham, Ala.

* * *

Walter Laib has severed his connection as chief chemist and superintendent of the Ohio Salt Co., Rittman, Ohio, to assume the position of treasurer and sales manager of the Cleveland Match Co., Cleveland, Ohio.

* * *

Henry N. Thomson, at one time head chemist of the Anaconda Company and later superintendent of International Smelter, Tooele, Utah, has been appointed

to the chair of metallurgy, University of British Columbia, Vancouver.

* * *

Karl B. Norton, formerly with the Semet-Solvay Co., and for the past three years at the Brooklyn plant of the National Aniline & Chemical Co., has returned to the Semet-Solvay Co., Syracuse, N. Y., as assistant to the chief chemist, Dr. A. C. Houghton.

* * *

Joseph T. Lawrence, chemical engineer, formerly with E. I. duPont de Nemours & Co., has been appointed plant superintendent of the Mitchell-Rand Mfg. Co., to succeed Charles L. Rand, who will devote his entire time to research work.

* * *

Dr. C. O. Johns, chief of the color and protein laboratories of the Bureau of Chemistry of the Department of Agriculture, has resigned to accept the offer made him by the Standard Oil Company of New Jersey to be director of the research laboratory of the company.

* * *

Pierre S. du Pont, head of the E. I. du Pont de Nemours & Co., and the Du Pont Securities Co., has been elected president of the General Motors Corporation. Mr. du Pont entered upon his responsibilities in the chemical industry as a graduate chemist, 1890, of the Massachusetts Institute of Technology.

* * *

Frank Crossley, consulting chemist and chemical engineer, formerly with the Curtiss Aeroplane and Motor Corporation, has joined the firm of Rackowe and Company, export and import, 395 Broadway, New York, and will take charge of the chemical department.

* * *

C. M. Weld, mining engineer; D. M. Liddell, chemical engineer and metallurgist, and P. H. Lazenby, civil engineer with wide experience in public utilities, have formed a partnership for practice as consulting engineers and economists under the firm name of Weld, Liddell & Lazenby, with offices at 2 Rector Street, New York.

* * *

C. E. Stecher, A. S. M. E., formerly assistant chief engineer for the Pearson Engineering Corporation, with which concern he had been identified for sixteen years, and latterly chief engineer for Gaston, Williams & Wigmore, has recently become affiliated with Glander & Company, engineers and dealers in chemical machinery and equipment, 800 Broad St., Newark, N. J.

* * *

Thomas M. Rector, formerly in charge of the Division of Food Technology of the Institute of Industrial Research, Washington, has been appointed director of the Department of Industrial Chemistry of the Pease Laboratories, Inc., 39 West Thirty-eighth Street, New York. During the war, he served as an officer in the chemical warfare service and was active in the perfection of the American gas mask.

* * *

Norman C. Hill, who was superintendent of acid plants at the Naval Proving Ground, Indian Head, Md., has resigned that position to become superintendent of acid production with the Monsanto Chemical Works at East St. Louis, Ill. He will have direct charge of contact and chamber plants, muriatic, chlor-sulphonic acid, nitric acid and zinc chloride manufacture.

Industrial Notes

The Southern Cotton Oil is building a \$100,000 paint plant at Savannah, Ga.

* * *

The United Filters Corporation announces that the general offices of the concern will be located in Hazelton, Pa., on and after January 1, 1921.

* * *

W. T. Wiegand, manufacturer of chemical glass apparatus, has succeeded the firm of Wiegand & Schreiber, 141 Lexington Avenue, New York.

* * *

The Bausch & Lomb Optical Co., Rochester, N. Y., manufacturer of optical and scientific instruments, precision equipment, etc., has increased its capital to \$6,000,000.

* * *

Geo. M. Hancock and David M. Hancock, Olean, N. Y., and Edward Rutherford, Belfast, N. Y., have incorporated the Union Charcoal & Chemical Co. with a capitalization of \$250,000.

* * *

The Sanborn Chemical Company, of Bound Brook, N. J., has leased the plant of the Elmer Automobile Company, Putnam, Conn., and will install machinery for making coal tar intermediates.

* * *

The Diamond Match Co., 111 Broadway, New York, will enlarge its Springfield, Mass., plant by the erection of a new power house, office building and storage structures, costing \$213,000.

* * *

The Atlas Chemical Co. and the Empire Chemical Co., Toledo, Ohio, devoted to supplying artificial gas to the Overland motor plants, have consolidated under the name of the former corporation with \$2,000,000 capital.

* * *

The Hord Color Products Co., Sandusky, Ohio, has awarded contract to H. K. Ferguson, of Cleveland, Ohio, for the erection of a new plant on the site of the one recently destroyed by fire. Construction will be completed by March 1.

* * *

The Canadian Libby-Owens Sheet Glass Co., Hamilton, Ont., recently incorporated with a capital of \$5,000,000, will start work immediately on the erection of a large plant at that city. Ralph King, of the Dominion Glass Co., Montreal, is president.

* * *

The Lexington Laboratory Supply Co., Inc., 210 East Lexington street, Baltimore, Md., has been incorporated with \$22,000 capital stock to manufacture instruments, apparatus, etc. The incorporators are Edward F. Peroutka, Kerner F. and Courtney F. Brown.

* * *

The Ford Motor Co., Detroit, has commissioned Stone & Webster, 147 Milk Street, Boston, to prepare plans and handle the engineering work in connection with its proposed new plant at Green Island, Troy, N. Y., for the manufacture of tractors, parts, etc. It will include a hydro-electric power plant.

* * *

The Hachmeister-Lind Chemical Company, 1910-12 Forbes street, Pittsburgh, Pa., manufacturer of chemicals, has acquired property on Island avenue, McKees Rocks, Pa., 130 x 600 feet, for a plant for the manu-

facture of chemical specialties. The company recently disposed of its present works on Forbes street.

* * *

The organization of the Pabst Corporation, Milwaukee, Wis., capital \$5,000,000, marks the passing of the Pabst Brewing Co., of late concerned only with the sale of hops and near-beer. The new corporation is empowered to "manufacture, sell and deal generally in goods, wares, etc."

* * *

The utilization of sugar cane bagasse for fibre board for building construction will be undertaken by the National Pulp, Paper & Cordage Co. of New Orleans, La., which is building a plant in that city for this purpose under the plans of Dahlberg & Co., Inc., Wilmington, Del., at an estimated cost of \$400,000 for the first unit.

* * *

The Corning Glass Works, Corning, N. Y., started in operation on Dec. 9, the first unit in its recently built two-unit plant at Kingsport, Tenn., for the manufacture of Pyrex transparent oven ware, and which will be known as the Southern Division. The plant consists of eight buildings, and the employees number between 250 and 300.

* * *

The Murray Oils Corporation, Wensley St., Philadelphia, Pa., has been organized by William P., Joseph A., and Philip J. Murray, who are respectively president, vice-president and treasurer, to manufacture oil from fish transported by boats from the fishing areas. A 2-acre site has been acquired for a plant which on completion will be one of the largest of its kind in the country.

* * *

The International Fibre Co., El Paso, Texas, capital \$500,000, has been organized by F. B. Hadlock and others of that city to manufacture rope, twine and brushes from the fibre of the Lichiguilla cacti which flourishes abundantly in that section. John W. King of El Paso has invented a machine for defibering the cactus leaf, which has a daily production capacity of 1,000 lbs. of fibre and which also will be manufactured by the company.

* * *

The Portland Vegetable Oil Milling Co., Portland, Ore., has been organized by Portland men comprising C. A. Painton, president; B. C. Ball, vice-president; Prescott Cookingham, secretary, and C. A. Edwards, treasurer, and who with S. L. Eddy, M. S. Hirsch, H. H. Ward and F. W. Watson constitute the directors. The chief raw material, copra, will be received at tide-water at a 100-ton-day plant to cost \$450,000. \$700,000 already have been subscribed to finance construction and cost of site.

* * *

The Joseph Campbell Co., Camden, N. J., of which Dr. John T. Dorrance, a '95 chemist of the Massachusetts Institute of Technology, is president and general manager, has acquired the plant of Reid, Murdock & Co., of Chicago, Ill., at Hammond, Ind., comprising eleven manufacturing buildings on a sixteen-acre tract, with 350,000 square feet of floor space, for a reported sum of \$300,000.

In contemplation is a plant in Canada and another in California in accordance with expansion policies of the company that require more direct access to raw materials and greater efficiency in distribution of its food products.

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Industry Resents the Competition of Its Help

A Criticism of a Socialistic Scheme, Which True to Form, Arises from Injustice

By Irving B. Smith

Director, Research Department, Leeds & Northrup Co., Philadelphia

IN the December issue of Chemical Age Dr. Frederick G. Cottrell, then Director of the Bureau of Mines and now Chairman of the Division of Chemistry and Chemical Technology of the National Research Council, a private enterprise, informed us that the measure authorizing the Federal Trade Commission to accept the assignment of inventions, patents and patent rights from employees of the Government, was "the culmination of the earnest thoughts of many minds both in and outside the Government service." Dr. Cottrell also stated that it was kept as a rider on the Patent Office bill in order to prevent effective opposition through misunderstanding or narrow self-interest.

To those in the Government service, this measure is decidedly one of self-interest, therefore, we presume self-interest is not to be avoided, but only the particular type that does not support the measure. This bill so vitally affects a large part of the public that to handle the matter fairly demands that the opinion of the public be given greater weight than the desires of a relatively small group in whose interests the bill plainly is drawn.

First Show that Present Procedure is Harmful to Industry

The principal argument for the measure is that there is scientific material of great potential value continually developed in government technical work which would, by this means, become available to industry. The writer is most ready to agree that much scientific data of direct value emanates from various Government departments; so much, in fact, he is the more unwilling to believe that a great amount is going to waste for lack of publicity.

It has been in no way demonstrated that any material



IRVING B. SMITH

Director, Research Department, Leeds & Northrup Co., Philadelphia

harm has been done to the public by the manner in which Government work is now presented to industry; and until this is reasonably evident the argument for the measure appears to be without foundation.

Results Reasonably to Be Expected

If this measure becomes a law, it will not increase the amount of useful material forthcoming, but will lessen and delay its application. In the practical operation of the bill, the Government work must be done in secret or the measure fails of its purpose. All ideas that may finally be worthy of patent protection and all ideas that individual government employees in the scientific departments may think or hope are worthy of protection, will be kept secret until such time as they have been so completely developed as to insure that their exposure to the public will not result in some one else so improving on them as to tie them up in a practical way by getting subsidiary patents. A considerable time will elapse between the laboratory completion of an idea and its final development to a point where it fits completely into industry.

Moreover, the subject will generally remain in the hands of the original inventor and probably in many cases not in practical hands. All of the industry of the country and all of its inventive ability are to stand still and wait until some man whose practical bent may be slight develops the idea to a point where it can not be materially improved upon:—a beautiful scheme. Plainly is being lost a great opportunity of placing fundamental facts before the country, where many minds, with many viewpoints and diverse problems, may co-ordinate their efforts in putting such new facts to the best and quickest service.

A development in a Government department may be with one application in view while its chief value lies in

quite another field. This more important application can not proceed, however, because the work is being carried on secretly by a Government employee and may not be released to the public for a long time.

Secrecy in the operation of the Government departments will gradually extend, for each man will feel that he has an idea that is a winner and he will not care to lose its control by divulging it. This will end the cordial relation which now exists between Government departments and manufacturing concerns.

If this measure is intended to return a considerable revenue to the Government in the form of royalties for paying salaries then there is implied great activity in getting commercial results and corresponding lessening of efforts along lines that represent the legitimate functions of the various departments.

Many of the departments are overburdened with legitimate work. What will result if this work is to be supplanted with the perfecting of numerous details in the process of carrying out to industrial completion some of the work that is now being done? For one thing it will mean that the minds of many research men will be engrossed in petty industrial details. Furthermore, the results which follow will not in many cases be as good as if the fundamental idea were taken out of the hands of the one who originally conceived it and developed from a new viewpoint.

Government Officials Are Good to Their Friends

Perhaps the most vicious idea in connection with this bill is the proposal to have the Government use its power to control and restrict trade by limiting the enjoyment of patent rights to a few whom the Government may choose. The choice may not be an economic one, but may depend upon the whim or favoritism of a subordinate who has previously taken the subject up with some manufacturer.

The industry as a whole is to pay Government employees to make inventions and then the Government is to refuse the right of some part of that industry to enjoy the rights which they all should share. We recognize of course that this is the function of a patent, but we question the wisdom of such a monopoly when it has not only the force of a patent right, but is also backed industrially by the national government and by government patronage as well.

To further strengthen this monopoly it is proposed to hold the subject in secret long enough to insure that there is no chance for further improvement. Dr. Cottrell says that a certain amount of discrimination will have to be shown with regard to licensing. He also says that this measure is placed as a rider on another bill so as to make criticism ineffectual. Presumably the same consideration will be given to the voice of public opinion if the measure becomes a law and is unwisely or unfairly administered.

A Subterfuge for Adequate Remuneration of Government Scientists Unjustly Denied

This measure appears to be a makeshift to supply the deficiency of inadequate salaries by furnishing another source of revenue. It will probably not do this excepting in a very inequitable way.

The most important reason for increasing salaries is to hold the able men now in Government service and attract others of like ability. Under the operation of this bill salary increases instead of going to those who are conscientious and capable research men will be distributed in accordance with the opinions of some individuals not thoroughly acquainted with the men and their work. It has been said that college professors are rated by the number of reams of research material they

publish, not by its quality; presumably some such method will apply in this case. Having once established this means of paying increased salaries or specific awards it will react strongly against any fair readjustment all around. The tendency of this lottery scheme will be to leave every one uncertain as to what will be the returns for his labor.

Finally it will lower the standard of recompense because many men of mediocre ability but of some inventive talent will seek a place where all facilities are provided for inventors and a salary paid while they work. The salary with them will be a matter of secondary importance and, therefore, they will be instrumental in lowering the salary requirements. Their chief interest will be to exploit their own inventions.

As suggested by Dr. Cottrell, this may seem like a very poor estimate of the type of man now in Government service, but the writer does not fear the warning that he "will show a more cynical estimate of this type of man than is believed justifiable," for the reason that with the normal turn-over this type of man will be gone from the Government service before this measure can pass the experimental stage. Consequently any remarks, invidious or otherwise, made here will not apply to the present force, but to a new one lured to the service by a very different bait than that which attracted the present men.

Contrast of Proposed Procedure with Private Practice

There is no stipulation in this bill that employees *must* tender their inventions to the Government, but simply that if they do so the Government is empowered to accept them. This measure, therefore, does two things. First, it legalizes and moralizes, you might say, taking out patents by employees when working for the Government at the expense of the Government. Second, it establishes that the employee does not have to tender the invention to the Government if he does not want to. The custom will be definitely established that each man's work is his private property to do with as he sees fit. Dr. Cottrell implies that this bill follows the custom of industry, but please note that the technical worker in industry is usually under contract to turn his inventions over to the company paying his salary; he has not the option of withholding them if he prefers.

Better Mandatory Than Permissive

The writer is particularly impressed with the opponents' reiteration of the tentative nature of this bill. Apparently the shadow of doubt as to its virtue looms large even before their eyes, and they earnestly wish to impress us with the permissive nature of the measure. It would be far better if it were mandatory and much safer to know what definite things would be done rather than what indefinite things might be done.

Some Constructive Criticism

The statement has been made that no constructive criticism of this bill has been offered. In some instances that is within reason. If one were to suggest a way to build a ladder to the moon probably constructive criticism would not be forthcoming. However, by way of an attempt toward constructive criticism the following is suggested.

First, face the facts honestly and pay government employees what they are worth. Take the money for a couple of battleships while we are trying to find out whether or not we want battleships, airplanes, submarines, or missionaries. Second, have all government employees sign a contract to assign their patents to the

Government when they relate to the work for which they are employed. Then dedicate the patents to the public with this proviso, viz., that only those may use them who in turn will license others to use such subsidiary patents as may be taken out.

An Unsound Contention

The argument that an invention, dedicated to the public, does not interest capital is not sound. Most capital

is employed under conditions where there is no patent protection.

The United States is a large stock company employing many workers in Government departments. Whatever these workers produce belongs to the stockholders and in accordance with the above suggestions no stockholder will be in position to embarrass any other stockholder in the enjoyment of the results of the company's efforts.

American Enterprise Makes "Rare Earths" a Misnomer

By G. A. Pritchard

Vice-President, Buckman and Pritchard, Inc.

A DOMESTIC production of 15,000 tons per year of minerals heretofore characterized as the "rare earths" not only indicates the reaction of supply to demand, but casts into the oblivion of the obsolete the term "rare earth."

The properties of these "rare earths" made the demand for them in various industrial processes so insistent that scientific research and commercial enterprise provided the supply. The German exploitation of Brazilian deposits was on a laboratory scale in comparison with the American development of domestic resources. These minerals are zircon, ilmenite and rutile.

The American manufacturer has been quick to realize the advantage of this new source of supply at home. Already, in scores of products, the new materials are taking their places to make better goods to stand the competition with foreign producers. In hundreds of laboratories throughout the country zircon, ilmenite and rutile are being investigated with a view to employing them in an almost endless list of products.

As chemical curiosities certain remarkable properties of these minerals have long been known, and many more have come to light through recent investigation. But until American enterprise made them available in thousands of tons, these properties were of academic interest only. Today the manufacturer who wishes to impart to his product or utilize in his processes either one or more of the properties of great hardness, tremendous refractoriness, a super-brilliant lustre, high indices of refraction, low thermal conductivity, peculiar dielectric properties, great density, high specific heat, an unusual degree of inertness, a wonderful series of colors, valuable specific alloying properties, unique catalytic effects and a host of other properties, is looking more and more to these new minerals to improve his product, or to make possible new products hitherto unobtainable.

Zircon

This is the much discussed new material for crucibles and refractories, but it has other important uses. Zircon is a natural silicate of the metal zirconium, and when prepared in the pure form has the formula $ZrSiO_4$. It occurs widely scattered over the earth, but almost never in the pure state or in large quantities. The Florida deposits are the only large deposits known where the mineral occurs in a comparatively pure state. Zircon usually occurs combined with some impurities which give it a color, ranging from hyacinth to a dirty brown. One or two varieties, the Florida mineral among them, yield to a purification process consisting usually of crushing, grinding, washing and treating with acid, and can be made to yield a practically pure zirconium silicate. Zircon is now offered in several grades, ranging

in purity from about 80 per cent. to upward of 99 per cent. The degree of purity required depends upon the particular art in which it is to be utilized, but most of the trades require products which lie within the limits of 90 and 96 per cent.

Zircon is used in the industries either by itself for its own specific properties, or as a source of metallic zirconium or as a source of zirconium oxide. Of the three fields, its use by itself is undoubtedly of the greatest present importance. Among the qualities which this interesting substance possesses to a high degree are great refractoriness (a melting point of about 4,000°F.), a remarkable resistance to carbon and other slagging agents, a great density, a hardness above that of garnet, a lustre so close to that of diamond that it is difficult to distinguish between the two, a very low resistance to the ultra-violet rays, a low thermal conductivity, a remarkable pigmenting power when ground, an extremely low coefficient of expansion, an almost uniquely low electrical conductivity at white heat, an inertness to chemical action exhibited by few, if any, other substances, a very high index of refraction and other specific physical properties for which we have no convenient terminology. As a consequence of these qualities zircon is being employed in the most widely differing industries, among the more important of which are refractories, abrasives, dyes, glazes, enamels, paints, colors, gas lights, electric lights, cements, porcelains, papers, textiles, plastics, rubber, pharmaceuticals, etc.

The oxide of zirconium produced from zircon is used extensively to replace oxide of tin in vitreous enamels in the kitchen and sanitary ware trades in the same way that ground purified zircon itself is used. This is probably the most important use of the oxide, although it is also finding employment in certain of the finer chemical industries. It is probable that, owing to its extremely high melting point, it will find a limited use in laboratory refractories, although the ease with which it forms the carbide and is then destroyed will probably prevent its extensive use in commercial refractories. Zircon, the silicate, on the other hand, seems destined to play a great role in modern refractories and especially in crucibles.

Zircon, when reduced with the electric furnace, serves very satisfactorily as a source for metallic zirconium, and although the field of this wonderful metal has hardly been touched by organized research, the position of the element in the periodic table, coupled with certain specific properties, justifies the belief that in this direction also valuable results will be obtained.

Ilmenite

This is a natural titanate of iron, and the product offered is said to analyze very close to the formula

Fe TiO₃, showing a little over fifty-two per cent. oxide of titanium. In this respect the Florida ilmenite is most unique, for, although this mineral is very widely distributed in the earth's crust, its content of titanium dioxide seldom exceeds thirty-five per cent., and it may be said that the Florida deposits have for the first time made available tonnages of a fifty-two per cent. mineral.

Ilmenite is used both as a material itself, and as an ore from which metallic titanium and titanium salts are produced. The white pigment "Titanox," said to have two and one-half times the hiding power of the best white lead, is made from this ilmenite. The well known ferrocyan-titanium of the steel industry is another product of this ore. The mineral itself is used to produce valuable browns, yellows and blacks. It is also used in metallurgy, in ceramics, in arc light electrodes, in fluxes, etc. It serves also as the starting point of a large number of salts, of which titanium potassium oxalate is probably the chief. This mineral is almost weekly yielding valuable properties which well repay investigation.

Rutile

Rutile may be regarded as a practically pure, natural oxide of titanium. What has been said of ilmenite is also applicable to rutile. It has in addition some valuable specific properties.

Natural Sodium Sulphate

The scarcity of sodium sulphate as a by-product in the manufacture of hydrochloric acid from salt and the unsatisfactory natural production in volume and deliveries, together with the great demands of the soda pulp and glass industries for salt cake resulted in a spectacular market advance in this commodity and encouraged search throughout the west and southwest for deposits of natural Glauber's salt or mirabilite.

The chief sources were the vast Carrizo Plains deposits in San Luis Obispo County, California, certain clay deposits in Arizona and New Mexico, and a small quantity from Nevada and Utah.

A survey of the total data indicated the superiority in purity and accessibility of the product of the Wyoming fields. Closer study indicated the commercial possibilities of the Downey Lakes deposits, 13 miles southwest of Laramie, Wyoming, where approximately 4,000,000 tons of the natural salt rest in dry and semi-dry lakes.

Laboratory tests of this material conducted throughout the summer of 1920, at the University of Wyoming, indicated a Na₂SO₄ content in excess of 95 per cent. in the calcined product. The crystals ran 44 per cent. Na₂SO₄, iron-free and with trace only of the chlorides of lime and magnesia.

At the elevation of the deposits, 6,000 feet above sea level, the dryness quickly effects efflorescence on exposure, resulting in a product flour-like in color and fineness over the area of the lakes during the dry season from March to November.

While cheap trucking is practicable owing to the absence of grades, the proximity of the Downey Lakes to the Union Pacific Railroad, nine miles distant, encourages the early construction of a spur track from the deposits to the main line.

Anderson, Rogers & Co., Inc., 133 Front St., New York, is interested in the commercial exploitation of these deposits, which in abundance, purity and accessibility surpass any known in the United States.

Candle-Power Standard of Gas Measurement Represents the Slow Reaction of Politics to Technology

In an era that demands efficiency and conservation in the utilization of our natural resources, the outstanding example of political perversity that deliberately compels wasteful industrial practice is the action of the Public Service Commission of the First District of New York in the perpetuation of the candle-power standard for the measurement of illuminating gas in the metropolitan district of New York.

More than 80,000,000 gallons of gas oil annually are being needlessly used in furnishing Greater New York its artificial gas supply. At the present price of 12½ cents a gallon, this is worth about \$10,000,000.

The situation obtains because the gas companies are required, by law, to supply gas of 22-candle-power. By simply substituting a reasonable heat standard for the present antiquated candle-power requirement, the above amount of oil could be saved.

There is no better proof of the antiquity of the candle-power standard than the fact that Greater New York is only part of the Empire State where it is still in force. Three years ago the Public Service Commission for the Second District of New York, comprising all of the state outside New York City, changed to heat unit standard.

There was some excuse for the candle-power standard when it came into existence many years ago. Gas then was consumed universally as an illuminant and needed the enriching quality of the oil. Today New York City uses gas for heat, either in cooking, in the trades or in incandescent lights. Less than 5 per cent. of the gas consumers in Greater New York use the old fashioned flat burners for illumination. Obviously the candle-power standard has outlived its usefulness. The 5 per cent. still using obsolete burners could substitute readily Welsbach mantles which illuminate by reason of the incandescence of the mantle.

New York City's gas companies serve about 64,600,000 cubic feet of gas annually. Of this 91.3 per cent. is water gas which requires oil to meet the standard. In turning out this gas supply the companies use about 256,600,000 gallons of gas oil a year, costing now over \$32,000,000.

Gas engineers figure that the substitution of a heat unit standard of, say, 525 British thermal units, would reduce the amount of gas oil used in making 1,000 cubic feet by 31 per cent. This would mean a saving of 1½ gallons a thousand feet, with a consequent reduction in cost of about 16 cents. Under the candle-power standard it is necessary to use about 4¼ gallons of oil a thousand feet.

Massachusetts, Connecticut, New Jersey and Philadelphia, to mention a few places, have had heat unit standards for several years which run between 525 and 528 British thermal units. After three years of experience with a standard of 585 units, the up-state Commission for New York is holding hearings on the advisability of reducing the standard to 525 heat units.

Apparently something should be done to eliminate this antiquated standard, particularly in view of the difficulty which gas companies are finding in obtaining an adequate supply of oil even at high prices.

The Tennessee Copper & Chemical Company made a new record in the production of sulphuric acid in 1920, turning out a total of 333,629 tons.

New Contacts Between the University and Industry

A Report of Progress in the Reciprocal Service of Teacher and Plant Manager in the Training of Chemical Engineers

By Warren K. Lewis, Ph.D.

Professor of Chemical Engineering, Massachusetts Institute of Technology

THE technical school exists to serve industry and finds in the progress of manufacturing arts and, through them, in the increase in social well-being the results of its service.

The desirability of closer co-operation has grown with the appreciation of the technical professional man's contributions to material progress. Just as a manufacturing organization is known by the quality of its product and the character of its service, so is the school known by the projected representatives of its ideals of service. That these representatives may be in the highest degree adaptable, resourceful and responsive to the needs of industry, the desirability of this co-operation is obvious.

The School of Chemical Engineering practice of the Massachusetts Institute of Technology is the culmination of efforts in this direction originally proposed and outlined by Dr. A. D. Little. This plan was launched in 1917 and, although in successful operation at the outbreak of the war, was discontinued because staff and students went almost as a body into war activities. After the war the plan again was put in operation, and is proving so successful that it seems worth while to make a report of its progress.

The plan of Dr. Little contemplated the admission of students of chemical engineering into industrial plants, so that these plants could be utilized as laboratories of engineering instruction. Dr. Little pointed out that, despite the variety of chemical industries, manufacturing operations consist of a relatively small number of unit operations, and that it is possible so to choose the cooperating plants as to cover practically all types of chemical engineering work.

School of Chemical Engineering Practice

The School of Chemical Engineering Practice was established in cooperation with the Eastern Mfg. Co. and the Penobscot Chemical Fibre Co., paper manufacturers in Bangor and Old Town, Maine, the Revere Sugar Refinery, the Merrimack Chemical Co. and the Boston Rubber Shoe Co. (a subsidiary of the U. S. Rubber Co.), the last three in the neighborhood of Boston, and with the Lackawanna Steel Co. and the Larkin Co., in Buffalo, N. Y.

The industries involved include the manufacture of sulphite and soda pulp, writing paper, electrolytic caustic soda and chlorine, the refining of sugar, the production of heavy chemicals, the manufacture of rubber products, pig iron, steel (both Bessemer and open hearth), coke and gas including by-product recovery, and soap and glycerin. These, however, are not chosen as specific industries, but as plants which present, in well-balanced coordination, illustrations of all the basic



WARREN K. LEWIS, Ph.D.
Professor of Chemical Engineering,
Massachusetts Institute of
Technology

unit operations of the chemical industry.

Thus, at Bangor, special study is made of extraction, absorption, evaporation and electrolysis. At Boston, emphasis is laid on the handling of materials, corrosion and filtration, while the plants at Buffalo give unexcelled opportunity for the study of metallurgical processes, combustion and furnaces, distillation, drying, and by-product recovery. In all these stations attention is paid to the economic organization of chemical industry, to the interrelation and control of the different departments and activities, and to the functions of the engineer in connection with them.

Discipline and Personnel

The work in each station is under the direction of a member of the Institute's faculty, with instructional assistance, resident at the plant. The attendance is limited to graduates in chemical engineering, competitively chosen on the indications they give of developing professional capacity for engineering work. The number is limited to twelve students or less per station, so that the ratio of students to instructor is less than five.

The students are not employees of the plant, but pay full tuition for the privileges of the school. Their activities are designed to yield the maximum of educational return to them and come under the continual supervision of the instructional staff. Some time is spent on shift work, but by far the major effort is put upon a careful study of industrial operations and processes, including quantitative engineering tests. These tests are not merely performed, but are designed by the students, the results interpreted by them, and in many cases recommended modifications and changes are introduced and followed up.

Scope of the School

This school offers to the student seven large industrial plants as an engineering laboratory. The engineering laboratory of a university necessarily consists of relatively small-scale equipment, divorced from its industrial setting, and, though maintained at great expense, continually growing obsolete. In the field of chemical engineering particularly, it is usually impracticable to operate such equipment under conditions at all duplicating commercial practice. Filtration, digestion, evaporation, electrolysis and the like are processes which can be operated only as steps in a larger circle. The plant furnishes the cycle and maintains the equipment in actual operation without cost to the educational institution.

Such a scheme is contrary to the former traditional secrecy of chemical industries. It will be noted that the cooperating plants have been limited to the non-secretive, standardized industries. In practically all the

plants all processes and departments are open to the students and, except in a few cases, information is available on all points and every department and operation are studied.

How the Plant Profits

It is obvious that such a scheme is of the greatest value to the student and the educational institution; but by what philanthropic impulse can the industries be induced to open their doors to the men? If the presence of the school in the plants is due to philanthropy, this scheme is sure to fail sooner or later, but this contingency is provided against by arranging a technical service to the companies to compensate them for the privileges extended to the school.

It is obvious that the activities of the school must in nowise interfere with manufacturing production. This, however, is but a negative good and, as will appear, it can be realized and at the same time positive benefits secured.

In the first place, not only the director of the station, but the whole staff of the Chemical Engineering Department of the Institute and, in lesser degree, its whole faculty, are at the disposal of the plant for consulting work. The staff of the station is obligated especially to cooperate in industrial development with the research organizations of the plant, and most satisfactory results have been realized along this line.

In the second place, it is possible for the activities of the students themselves to be of value to the companies. Every manager has in mind certain testing work which he would like to have done, or data which he would like to secure, but which must be neglected on account of lack of staff.

The first problem of the plant management is the maintenance of quality and quantity of production, and to this categorical imperative everything else is subordinate. Of course, the efficient manager prosecutes all testing and investigational work which is essential to the maintenance of production and to the improvement of processes and equipment, but no work of this sort can be undertaken unless of outstanding importance. Work of technical and economic interest and usually of great potential value must be omitted because of cost. This is all the more true because such work can be carried out efficiently, so as to insure reliability of results only by technically trained men, and the technical staff is always limited in number.

Specific Service of the Student Staff

The students of the School of Chemical Engineering Practice offer an auxiliary staff of technically trained men available for just such work, and it is obvious that this sort of engineering work can be made of economic value to the plant. Meanwhile such activities are of the greatest educational importance to the young engineer.

The student tackles a series of technical problems of real importance, distributed among the basic chemical industries. He works under the direction of men of training and ability in the atmosphere of a producing plant. Because of the immediate industrial importance of the problem the student not only feels a keen sense of responsibility, but works under a guidance and direction that eliminates the danger of serious errors.

The equivalent of this training and experience is open today to no other group of embryonic scientific workers, with the exception of those entering the medical profession. Moreover, just as the hospital practice of the young doctor represents a positive service to the community as well as an educational opportunity of great

value to himself, so this School of Chemical Engineering Practice is an economic asset to the manufacturer, as well as an unexcelled educational experience for the student.

Another result of potential value to the companies is the opportunity for research, especially in our post-graduate laboratories at the Institute. The industries have suggested a mass of problems well suited as subjects for theses for post graduate degrees, the investigation of which is being prosecuted in the laboratories at Cambridge. Of course, these subjects do not include the sort of topics which are being carried on by the research laboratories of the companies themselves, but do involve the solution of scientific problems of general interest and specifically applicable in the industries suggesting them, but for the solution of which the companies themselves do not have adequate staff.

Familiarity with the Needs of Industry Improves Technical Educational Practice

Finally, this School of Chemical Engineering Practice furnishes a continued point of contact between the Institute and the cooperating companies. Both the University and Industry have much that each can give the other, but contact is necessary to furnish an opportunity for mutual helpfulness. The university offers a broader and deeper contact with the whole field of scientific knowledge. Industry has a knowledge of the hard facts of experience which can be used to temper and strengthen scientific and educational theories and make them more applicable and useful things.

There can be no question that the intercourse of the Department of Chemical Engineering at the Institute with the industries cooperating with the School of Chemical Engineering Practice has clarified our knowledge and improved our educational practice. Whether the companies have similarly profited from their contact with us is for them to say, but if not, it has not been for lack of hearty and pleasant cooperation on both sides.

A Misapprehension Corrected

It seems necessary to correct one misapprehension with regard to the character of the school. It has been confused with the plan introduced and so successfully developed years ago by the University of Cincinnati and since adopted by others. It is felt, however, that this school is an entirely different type.

In the first place, while, under the former plan the students go out into industrial work from the beginning of their collegiate course, our students are graduates in Chemical Engineering before they start work in the plants. A student in his freshman, sophomore or even junior year in school is not in a position to profit on the technical side of his training in any marked degree from industrial work. He does not know enough to appreciate what he sees.

We, at the Institute, fully understand the value of industrial experience to the undergraduate student in engineering. We urge and help our students to secure summer jobs in engineering work and recognize that they profit greatly from such activities, but every engineer realizes that the student profits on the personal rather than on the technical side.

This personal development of the student is of the utmost importance. No one is admitted to the School of Chemical Engineering Practice who does not show real promise along this line, and the school at all times develops and expands this side of an engineer's activity; but as for technical training, it is imperative that a thorough theoretical foundation be laid before engineering experience can start.

In the second place, the student of other cooperative schools goes out as an employee of the company. This is of value to the student in that it helps him to earn his way through the University, but it means that the company must keep him at such work as will enable him to earn his pay.

Before a man can earn his wages on a job, he must become experienced at it and long before such experience is acquired, the educational value of the job largely has disappeared. Under such a plan it is not possible to arrange the activities of the student so as to secure the maximum of educational return to him, whereas this is exactly what is done in the School of Chemical Engineering Practice.

Finally, in the School of Chemical Engineering Practice, the student works continuously under the educational direction of the instructing staff of the Institute.

A manufacturing company is not an educational institution. It is organized for a different purpose, viz., production. In this school the plant is used as an educational laboratory, but the educational work is carried out by an educational organization, designed for the purpose, with a personnel chosen for educational efficiency.

After six months of intensive work in the Practice School, the student returns to the Institute for two-thirds of a school year of post-graduate study and research leading to the degree of Master of Science. It is believed that this course offers an educational opportunity in chemical engineering at present unexcelled. If the scheme ultimately proves the success that we feel it is becoming, it will be introduced elsewhere, not merely in chemical engineering, but in other branches of engineering as well.

Eastman Kodak Company and the Sherman Anti-Trust Act

THE final adjudication of the government's original bill of complaint against the Eastman Kodak Co., filed June 9, 1913, for violation of the Sherman Anti-Trust Law in the maintenance of a monopoly in photographic supplies resulted, on January 31, in the company's withdrawal of its appeal to the United States Supreme Court from its conviction before the United States District Court at Buffalo, N. Y., and the filing of a decree in the latter court on February 2 requiring the disposition of about \$4,000,000 of assets which total \$90,000,000. District Judge Hazel in his opinion, handed down August 24, 1915, affirmed the government's contentions practically in their entirety. These included the charge that the Eastman Kodak Company of New Jersey, capital \$35,000,000, and the Eastman Kodak Company of New York, with a capital of \$5,000,000, controlled 72 per cent. of the market for their product, and that the resulting monopoly has been imposed through the defendants' terms of sale, which prohibited dealers from handling supplies manufactured by any other concern.

The Kodak Companies' alleged policy of strictly fixing retail prices was attacked, as was the system of operating retail or stock houses as ostensible competing plants.

Individual defendants named in the suit included George Eastman, Henry A. Strong, Walter S. Hubbell and Frank S. Noble, all officials of the parent company and residents of Rochester, N. Y.

The decree involves no substantial disruption of the organization which will carry on its business with renewed confidence. Among other things the decree directs the sale of the Premo and Century-Folmer and Schwing factories at Rochester, N. Y., and the Aristo plant at Jamestown, N. Y.

The Rochester plants ordered to be sold employ only 722 of the 11,700 employees of the company in Rochester, and represent an investment of \$3,786,000, with 1920 sales in excess of \$7,000,000.

Historical

Photography's crude beginning dates from Daguerre's discovery in 1839 and Dr. Draper's first daguerreotype in America made in 1840. Film photography, now universal, dates from 1889 when George Eastman demonstrated the use of nitrocellulose as a vehicle and support for the silver salts sensitive to light, after an experience of ten years with the unsatisfactory material and cumbersome equipment then in vogue.

The creation of the photographic industry and the transformation of the practice of photography from a professional art to an amateur pastime, with its important industrial and commercial applications, are the work of one man who drew about him in the development of its business throughout the world many technical men whose alertness and loyalty he rewarded not only directly in the present, but for all time made possible their propagation in his princely endowment of the Massachusetts Institute of Technology.

Just as Daguerre saw the professional possibilities of his discovery, so Eastman saw the commercial possibilities of amateur photography and to the instinct of the inventor added the capacity of the organizer and administrator, to which rare combination was vouchsafed the timely development of the motion picture. Edison required a transparent, flexible film combining good photographic quality with tensile strength, which Eastman supplied and which the company's plants now produce per annum in excess of 125,000 miles.

Results of Dissolution

Experience has shown that dissolution enforced by government action under the Sherman act has not been without benefit to the corporations involved as expressed in the subsequent market value of the securities of the segregated organizations. Ten shares of the Eastman Co. common stock sold on Feb. 1 on the New York Stock Exchange at 640, an advance of 143 points over the last sale, the sales being so infrequent as to be notable. The advance in the stock is due to plans for segregation which are interpreted as a favorable development.

Of the authorized capital stock of the Eastman Kodak Co., \$19,586,200 of the \$25,000,000 (par \$100) authorized common stock have been issued and \$6,165,700 of the authorized \$10,000,000 preferred stock.

The corporation earned \$91.78 a share on its common stock in 1919, a net of \$18,326,188, compared with \$70.02 in the previous year. Earnings for 1920 greatly increased because of the corporation's tremendous sale of film to the motion picture industry. The corporation's annual meeting will be held on April 1 in Jersey City, when the plan of segregation will be acted on.

The American Glue Company will enlarge its plant at Peabody, Mass., by the erection of an addition to cost \$25,000.

American Institute of Chemistry

Additional Observations on the Project of an Economic Organization of Chemists

THE registration, certification and the enlistment of legal sanction to the work of a private group by a system of mandatory or permissive licensing to the end that the work of the chemist may be dignified by extraneous approval as a profession, is a subject that will be discussed until such steps are taken as will provide the experience whereby publicly the sheep may be separated from the goats.

Such a movement is a symptom of economic dissatisfaction.

This fetish of a label is worshipped by those who having submitted to the discipline required as a basis for proficiency resent the demoralization in remuneration wrought by those who pursuing the essential, elementary, repetitive work, also assume the same label. This relative deficiency in the cultural requirements contributes to the development of the "gang" spirit, without as yet evolving a character who can personify in something practical the suppressed emotions of those who deem themselves the "elect."

In the January CHEMICAL AGE we discussed briefly the morphology of the chemist and characterized him as a transitional character in the economy of the chemical industry and described his work as an analyst as being preparatory and determinative of broader and more intensive usefulness in the work of production.

A small group of chemists, who constitute a handful in the body of chemically educated men engaged in the chemical and allied industries, are engaged in the work of consultants. These men have the commercial instinct. Their success is predicated upon their faculty of merchandising what they know. A much larger group of the same general mental characteristics are administrative men in chemical manufacture. They know what products are needed and can be sold and keep in intimate touch with competitive activities. They direct the work of plant executive chemists who are recruited as they show ability from chemically trained men who are taking their initial steps in industry. Aside from the laboratory, throughout the plant are chemically trained men of the same academic origin engaged with the larger instruments of production and who are equally responsive subjects of natural selection.

Moreover, in every department of the chemical and allied industries are found chemically trained men who upon their technical education engraft the special knowledge or skill demanded by their duties.

The day is not far distant when the chemical industries will be manned throughout by chemically trained men.

Industry in its growth becomes increasingly keener for men of managerial capacity.

In this pyramidal structure of technical ability as represented by the superimposed groups, what we wish to

emphasize is the play of specialization and coordination in the economy of production. The essential directive and creative characters are chemists, each doing what he can do best and ascending as opportunity and fitness meet.

No chemist, however rare his accomplishments, today presumes to take all industry for his province.

It is this specialization that makes difficult the definition of a chemist and highly uncertain of results of any great practical value any project to cabin, crib and confine under a professional label this important factor in industry.

Efforts at organization of chemists may be classified in two groups, viz.:

I. Those looking to the segregation of a special class of chemically trained men for the exclusive benefit of members of the class, and

II. Those looking to the segregation of chemically trained men for the benefit of the chemical industries in whose progress lies their own advantage.

Advocates of group I, while they may not intend to seek to benefit themselves by putting others at a disadvantage, are committed to such a course of delimitation as to make doubtful any benefit to themselves. Experience teaches that group pursuits for direct and exclusive benefit and advantage to members, as a rule, fall far short of intended realization.

Advocates of group II have the sanction of experience and the precedent of progress.

The "public" does not employ chemists; the only species of the genus with which it comes in contact is the pharmacist. It is industry that employs chemists, whatever may be their classification, and they can work out their salvation only in industry. The chemist is unique among professionally trained men in his aloofness from those for whose

benefit his service ultimately is performed.

We have discussed already* the structure and functions of a proposed organization of chemically trained men that promises most for the industry and for chemists. This discussion was grounded in practical experience and common sense without any of the frills and furbelows of the impractical and unnecessary.

We venture the assertion that if anything is done, and certainly it should be done, to promote the economic solidarity of chemically trained men, it will be worked out along the lines there laid down.

The efficient utilization of chemically trained men is a problem of the chemical industries; likewise, the subject of their economic solidarity. The studied neglect and discouragement of the economic organization of chemically trained men await only leadership.

Capable leadership will see that problems of individual welfare are problems of the chemical industry and can be solved only progressively and as part of a whole.

ORGANIZATION among chemists, among all technically educated men, should be encouraged if for no other reason than that there may be not only competition in service to their members, but that the discussion of it may be a spur to the activity of existing organizations.

Superiority breeds seclusion. The bars that hedge about the favored man must be broken down that the fruits of his favor may be shared by all, for in this way lie progress and the fulfillment of the responsibilities that society expects of its educated men.

The academic training of the chemist is not of a type that conduces to mixing with men and the growth of qualities that the market place alone brings out.

Contact with one's fellow teaches a man his deficiencies and emphasizes his gifts, which process should not be left entirely to time and the tragedies of middle age.

The chemist needs the friction of his fellows to brighten his resourcefulness and to bring into prominence his place in the economy of things.

—Editorial, CHEMICAL AGE,

February, 1920.

*CHEMICAL AGE, January, 1920, pp. 22-24.

Constructive Suggestions Regarding Muscle Shoals

By Frank W. Washburn

President, American Cyanamid Company

ECONOMIC considerations should be all-powerful in determining the future of Muscle Shoals Nitrate Plant No. 2. We continue to think in terms of old familiar peace conditions, while, as a matter of fact, the economic situation as it exists today is the result of war and it will be profoundly affected for an indefinite time in the future by the same cause.

The sources and available supplies of important articles of trade, markets, demands, and competitive and cost relationships, have been so changed that in many cases they bear no resemblance to these factors prior to the war. This is notably true of nitrogen and, therefore, there should be no surprise if the only feasible plan for the future of the Muscle Shoals nitrate plant bears little, if any, resemblance to those plans for Muscle Shoals which before the war gave promise of important economic results.

Enormous Surplus of Nitrogen Available

Nitrogen is the universal, active element in all explosives. The World War, surpassing all other wars in history, was distinguished above all others, in the quantity of explosives required by all combatants. To meet this situation every nation expanded and developed to the last degree every possible source of nitrogen. This explains the fact that the available capacity to furnish and produce nitrogen from domestic sources in America, as well as in Europe, is somewhat in excess of two and a half times what it was at the beginning of the war.

From a military standpoint, the production of explosives from the Muscle Shoals plant constitutes only a small fraction of the war time requirements in shell fillers, i. e., bursting charges. The military product of the plant, ammonium nitrate, is not used as a propellant; private powder companies furnish propellants, private steel works the artillery, the shells, the gun carriages, etc. The product of the Muscle Shoals plant is just one link in the chain of ordnance material and not even a controlling link.

Instead of being peculiar, exceptional or monopolistic, the Muscle Shoals Plant as a plant is, on the contrary, in the same class as practically all private establishments which furnished munitions during the war—food, fuel, clothing, arms, ammunition, transportation.

Because the Government has on its hands a war plant is no good reason for projecting a departure in our recognized national economic practices. The War Department sold powder plants, munitions works, food, clothing, fuel; the Muscle Shoals plant is in the same class as other war undertakings and in the final analysis

its disposal is reduced to a question of salvage.

The Government had prior to the war a well-defined policy regarding the maintenance of arsenals as a nucleus for military experimentation and preparedness, but the war demonstrated the relatively small part such establishments played compared with industry in furnishing munitions for our troops. In peace times arsenals do not compete with private industry.

Competing with a By-Product

The most important source of nitrogen supply in the United States is the by-product ovens producing coke for metallurgical and domestic uses. The most significant commercial factor which faces any organization contemplating the operation of the Muscle Shoals nitrate plant is the fact that the direct competitor of its product is an identical one originating as a by-product, namely, sulphate of ammonia, capable of being produced in quantities two and a half times as great as before the war.

In the nature of things there has been no corresponding increase in the peace-time demand for ammonia comparable with the increased capacity of the various countries to produce it. The enormous capacity of the Muscle Shoals plant is shown by the fact that it has 40 per cent. of the present capacity of the by-product ovens. Furthermore, a by-product can not be driven out of the market by competition, nor is the quantity in which it is produced determined by the demand for it. It must be produced without relation to the demand, and it must be sold without any relation to the cost.

Low Comparative Prices and Surplus of Sulphate of Ammonia

There was 100,000 tons surplus domestic production of sulphate of ammonia in the United States last year. This afforded 100,000 tons for export, substantially 50 per cent. of the domestic consumption. Correspondingly, in 1920, there is again a surplus of 100,000 tons available for export. The domestic price last year was a trifle over 10 per cent. in excess of the normal peace-time price, and this year it is 50 per cent. in excess of that price. The greater of these prices is smaller, or at least no greater, than would be the cost of production at the Muscle Shoals plant, even if we exclude from costs, interest on investment, local, State and Federal taxes, insurance of all kinds, including life, fire, liability, workmen's compensation, etc., and administration expense.



FRANK W. WASHBURN
President, American Cyanamid
Company.

Futility of Operating Muscle Shoals at Present

These conditions clearly show how little chance there is at this time of securing a profit from the operation of the Muscle Shoals plant. Further, they prove conclusively the utter impracticability of starting operations at Muscle Shoals under any circumstances on any, except the most modest, scale representing a small part of the full capacity.

The Muscle Shoals plant was built to manufacture an explosive material, ammonium nitrate, which constitutes 80 per cent. of the necessary and very largely used shell explosive known as amatol. It is essentially a military plant and only a part, not to exceed roughly a half of the plant, would be suitable for the production of a commercial material.

Objectives

As we see the situation there are two principal objects to be accomplished:

- I. To maintain the plant in readiness to manufacture the explosive material for which it was built.
- II. To make the largest commercial and economic use of the plant practicable and consistent with its primary military purposes.

These objects may be attained by the commercial operation of the plant in such parts and to such an extent as will prove commercially practicable, and by maintaining the idle parts of the plant in readiness for use.

Government operation of a commercial industry is impracticable for so many well known reasons that it seems hardly necessary to mention them. Fundamentally, it is the function of Government to govern and regulate and not to own and operate. Government is essentially political and its ambitions and actions must spring from those interests of mankind which are politically significant of personal rights and liberties.

While commerce and industry must not violate in their practice the principles of personal justice and liberty, they must be conducted from the viewpoint of the conservation of human energy and be based upon sound economic principles. They must meet the great test of being able to pay dividends. No Government has ever been able to apply economic principles to government or political principles to industry. There is an inherent and inevitable inconsistency in Government entering the field of commercial and industrial activity.

There are situations where the broad economic welfare of the country make it proper for Government and private interests to cooperate. War and the preparation for war are the one great notable example of the most complete cooperation between Government and its citizens. With the return of peace, however, all Government operation of industrial enterprises should cease.

Government and Dividends

The operation of the Muscle Shoals plant for the economic reasons given, will have to be undertaken in the beginning in a purely tentative way on a small scale, and the use of additional parts of the plant with increased production will have to be brought about as the market demand can be developed. Not only is it impossible to forecast how rapidly and for what purposes the plant could be operated, but it is also impossible to estimate what the profits would be from operation. Under such circumstances private interests should not be bound in a contract with the Government to the payment of any definite rental or any percentage of profit or any tonnage basis.

A Development Program

The kind of arrangement which would seem to promise best results for all concerned, might, in the light of these conditions and considerations, embrace the following features:

- I. The Government would retain ownership of the plant and arrange with private interests to operate such portions at such capacity for the manufacture of such products as the market would warrant and as would result in profits to the Government and the manufacturer.
- II. The first payment out of net profits would be made to the manufacturer at a fair rate on the capital employed, and an additional allowance for sinking fund on the fixed investment made by the manufacturer.
- III. Such portion of the net profits, if any there be, as remains after paying the allowances heretofore referred to might be:
 - (1) Devoted to the payment of a fair and reasonable per cent. upon the appraised value of that portion of the plant which the contractor is using, and upon such percentage thereof as the contractor's output represents in relation to the full capacity thereof.
 - (2) Divided between the Government and the manufacturer in such relative proportions as circumstances and conditions shall determine as right and proper and which shall be agreed upon between the parties in interest.
- IV. The manufacturer would maintain in condition as good as new that portion of the plant which he did not use and would be paid therefor by the Government the cost of the maintenance thereof and a fee agreed upon in advance.
- V. The manufacturer would maintain that part of the plant and equipment which he has in use in first-class working condition and in readiness at all times to be devoted to Government use in the manufacture of ammonium nitrate whenever the Government, in its judgment, might require the plant for that purpose.
- VI. In the event of war, and upon orders of the Secretary of War, the manufacturer would discontinue the commercial use of the plant and operate it for such purposes, at such capacity and in such manner generally as the Secretary of War might desire. In this event the entire cost of manufacture would be at the expense of the Government. The manufacturer should be paid for his services in operating the plant such compensation as the Secretary of War might determine to be reasonable and proper.

Kelly Island Lime & Transport Co., Cleveland, Ohio, will erect at Gibsonburg, Ohio, a one-story, 50 x 130 ft. hydrated lime plant, costing \$50,000.

* * *

Parke Davis & Co., Detroit, Mich., will enlarge its plant by the erection of a 7-story, 200 x 248-ft. steel brick and reinforced concrete manufacturing building.

* * *

The acquirement by petroleum producing and refining corporations of oil shale lands and the rapid development of research in the utilization of shale point to the early establishment of the industry on a commercial basis. The Union Oil Co. of California Pure Oil Co., Ohio Cities Gas Co., Carter Oil Co., Standard Oil Co., Midwest Oil Co., and the W. P. Hammon interests, of the United States, the Anglo-American and Anglo Persian Oil Co.s of London and the Var Coal and Oil Co. of France are noted as having acquired in the past year extensive deposits of oil shale.

Alcohol Production from Molasses

By George M. Appell

Chemical Engineer

WITH each tank steamer of blackstrap molasses clearing the West Indian ports of the cane-growing islands goes the agricultural wealth of their soils. Blackstrap, once the embarrassing trade waste, then of nominal value as cattle food and raw material for the production of limited quantities of industrial alcohol, now is heralded as a potential source of fuel. It is going to liberate the islands from the tightening grip of the price-climbing petroleum products and inadequate shipping facilities; also increase dividends for those who will work it up.

The sugar industry is quite alive to the fact it has been selling its birthright for a mess of pottage, thanks to the constructive publicity that the fermentation industries have received of late. Therefore we witness their substantial interest in the ways and means of distilling alcohol from molasses, with a view to establishing this new line of manufacture in conjunction with their major industry.

Distribution of the Molasses Output

The West Indies produce an average annual crop of 300,000,000 gallons of cane molasses. During 1920 110,000,000 gallons were used by the distilleries of the United States in the manufacture of industrial alcohol. The cattle food industry consumed approximately 50,000,000 gallons. In this outlet cane molasses meets competition from beet sugar molasses, which is used almost entirely in cattle foods, as a result of certain prejudices of the cattle feeder. Much of the molasses so cleverly marketed for human consumption has been blended with the original product of the islands. A fourth part of each year's crop is a total loss either from lack of transportation facilities or low consumers' demand.

Alcohol Production by the Crude Sugar Refiner

Increased production of beet sugar in the United States, and the new development of malt syrup, will tend to narrow the market for Cuban and Porto Rican molasses; even the demand for industrial alcohol may slacken for the next year or two, thus throwing back upon the island producers a larger portion of the annual molasses output.

With the Islands' demands for motor fuel and the several inviting export markets offered by neighboring Latin-American countries, the sugar interests materially would strengthen their economic position were they to give serious consideration to ways and means

of recovering the valuable by-products of their industry. What effect would such development have upon our own alcohol industry? Presumably a very beneficial effect, because it would throw us entirely upon our own agricultural resources. We should have to develop more extensively starch and sugar-bearing crops and these in turn would increase the average yields per acre of the other rotation crops on land already in cultivation, as was the case in Germany.

Encouragement would be given to the cultivation of our vast areas of semi-tropical and semi-desert lands.

In the manufacture of alcohol, efficiently and upon a profitable basis, consideration must be given to the following factors in the order stated: (1) plant—its location, size, lay-out, proximity to adequate water and

fuel supply and markets; (2) raw material—its collection, handling, the study of its physical and chemical properties and its processing; (3) yeast—the selection of a vigorous, efficient alcohol-producing race of saccharomycetes and their propagation; (4) fermentation—the adoption of a method best suited to the local conditions; (5) policy—to determine what grades of alcohol are to be marketed, so that (6) distillation, both the first and second steps therein can be conducted with maximum efficiency; (7) receiving and denaturing; (8) distribution; (9) ether

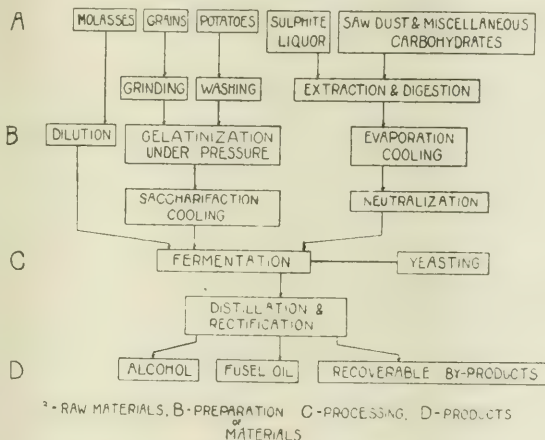


Diagram of Classes of Raw Material and Procedure of Treatment for the Production of Alcohol

production; (10) by-products recovery.

Plant

The first consideration in determining the location of the plant is the water supply; the right kind of water and ample quantities must be assured. For processing the molasses, well water is preferred; unstagnant river, lake or bay water would be next in line; salt water or brackish water are not to be considered. But any of these could be used for condensing and cooling purposes.

For every ton of molasses fermented would be required between 700 and 1,000 gallons of good water, the temperature of which should be around 80° Fahr. However, if it ranged up to 90° it could be used, provided coils were installed in the fermenters to maintain this temperature throughout the fermenting period. For condensing water the temperature should also range between 80° and 90° Fahr., colder water of course being preferred. It would require approximately 4,000 gallons of this water for condensing the distillates from each ton of molasses.

In the processing and fermenting of molasses very

little steam is required, just enough to run a pump for delivery of molasses and water, an air compressor to supply air as a stirrer and for the sterilization of the yeast-molasses. Not until the distillation process is reached does the consumption of steam feature. When this process is carried on economically it calls for exhaust steam fortified with live steam direct from the boilers. Where the intermittent type stills are used for rectification or redistillation, exhaust steam is far preferable to live steam.

Thus if an alcohol plant were located close to some other industry having an abundance of exhaust steam, or having some high temperature vapors which must ultimately be condensed, the heat units from these sources would materially cut down the fuel consumption in the alcohol manufacture. Of the total production cost per gallon, the item fuel represents between 50 and 60 per cent.; any economy brought about by clever engineering skill in this direction means that alcohol could successfully compete with petroleum as a motor fuel. However, in running a plant upon its own power house, approximately 4.4 boiler H.P. are necessary for each ton of molasses fermented.

The size of the plant should be determined by the amount of raw material that can be supplied conveniently at a low cost of collection and handling, so that operations could be maintained continuously or for such period of the year as local conditions will permit.

The design and lay-out of the plant should be carefully planned so that the materials need be handled as little as possible. Advantage should be taken of gravity flow to obviate the necessity of pumping. The raw material should enter at a logical point and flow in the shortest course to each step in the manufacture, always with that portion demanding the greatest amount of steam nearest to the boiler room or the source of heat, and the finished products coming out at a point where they can be expeditiously packaged and shipped.

With everything else being equal, the plant should be located in proximity to the largest and most profitable markets unless freight charges are so low as to be a negligible factor.

Raw Material

Molasses for some years past has been the cheapest available raw material for the production of alcohol. Just why this should be is forcibly illustrated by the accompanying diagram. It is quite obvious that all the other materials necessitate one or more expensive preliminary operations in preparation for the processes which are common to all.

Yearly Consumption in Gallons of Cuban and Porto Rican Blackstrap in Principal American Plants.

INDEPENDENT

Jefferson Distilling Co., New Orleans, La.....	13,200,000
Algiers Industrial Alcohol Co., N. Orleans, La. .	4,500,000
Everett Distilling Co., Everett, Mass.....	6,000,000
New Orleans Indust. Alcohol Co. N. Orleans.	6,000,000
Berg Bros. Distilling Co., Phila., Pa.....	10,500,000

U. S. FOOD PRODUCTS CO.

American Alcohol Co., New Orleans, La.....	9,000,000
Peoria Indust. Alcohol Co., Peoria, Ill.....	7,500,000

U. S. INDUSTRIAL ALCOHOL CO.

Central Division Distilling Co., N. Orleans, La. .	4,500,000
Internat'l Distilling Co., New Orleans, La.....	15,000,000
Louisiana Distilling Co., New Orleans, La.....	9,600,000
Curtis Bay Distilling Co., Baltimore, Md.....	45,000,000

From the molasses supply tank of the alcohol plant each day's quatum of raw material is pumped to the smaller mixing or processing tanks; they range anywhere from a thousand to five thousand gallons capa-

city and are placed either on weighing scales or built so as to permit of fairly accurate measurement by volume (gallons to each inch in height). They are usually situated on carrying beams about four feet higher than the tops of the fermenting tubs, so that after the molasses has been diluted and processed therein, it will run to the fermenters by gravity. They are each fitted up with a perforated coil for both air and steam; also a water line discharges into them. After measuring the charge of molasses water to the amount of its own volume is added; this mixture is thoroughly agitated by air. Whatever chemical processing may be found necessary by previous chemical control tests, is accomplished before the mix is dropped into the fermenting tanks.

Yeasting

It should be emphasized strongly that the successful manufacture of alcohol, even from the best raw material, depends upon two factors, viz., possession of a vigorous, efficient race of yeast, and conscientious, well-trained operatives to handle the major steps of the process.

There are many races and varieties of yeast possessing a wide range of properties. However, it is only those which induce alcoholic fermentation that claim our immediate attention. These occur wild in nature and upon the surfaces of fruits, cane, etc. Whenever they come in contact with a medium of the proper reaction (slightly acid), temperature and food-content, vigorous fermentation activities are witnessed, the sugars being split up into approximately equal parts of alcohol and carbon dioxide. Any variation of these conditions of the media results in a variation of the fermentation activities and in certain cases yielding decidedly different products.

An intimate study of the subject is necessary, not only in protecting this sensitive organism from detrimental influences, but also to stimulate and invigorate it during the process of multiplication or propagation from a single cell or test-tube culture to a volume sufficient to excite fermentation in hundreds of thousand gallons of material each day, at the same time maintaining its purity (both from a chemical and bacterial standpoint) and vigor throughout this process. In this way alone the greatest possible amount of alcohol will be produced from the sugars contained in the raw material.

Fermentation

This step in the manufacture is carried out in tanks of iron or wood of a suitable variety. Their capacity ranges from 5,000 to 200,000 gallons. Iron tanks are preferred for two reasons; viz., (1) they are more easily kept clean and sterile than the more porous wooden ones, and (2) they can be tightly covered and connected to the apparatus for the recovery of carbon dioxide gas, which today is proving a valuable by-product. Each ton of molasses produces 520 pounds of the gas. When compressed in cylinders of 25 and 50 pounds, it finds ready sale in the soft drink industry and a market can be developed for it as a fire extinguisher; also as a refrigeration medium it should be of special interest in the tropics, where low temperatures are required in industrial operations. Used in properly designed machinery, it has many advantages over the ammonia systems of refrigeration.

The fermenters are fitted up with a perforated coil for air and steam, a water line discharge of a size sufficient to completely fill the tank in at least two or three

hours, and a discharge line from the mixing or processing tanks and the yeast tubs. The fermenter is first cleansed thoroughly and sterilized with steam and sulphur dioxide or formaldehyde; then water is pumped in to about two-thirds the capacity. With the air turned on for mixing, the processed molasses is run in until the fermenter has received its full charge. The molasses thus is diluted to one to four, five or six gallons of water, as good practice dictates.

After the last gallon of molasses or "mash," as it is termed, has been added and thoroughly mixed, the proper percentage of ripened yeast is added. The air is kept blowing for about fifteen minutes, when it is shut off. Inside of three or four hours the first signs of fermentation appear in the form of pin-head bubbles or a bright yellow froth. Later this develops into a foam of large-sized bubbles and froth, which lasts until fermentation is almost complete. There is a vigorous agitation, with the appearance of a liquid being boiled, due entirely to the activities of the yeast. A fermenter is started at a temperature of 78° Fahr., with a density of 17° to 19°, or even 21° Brix. When fermentation has ceased the density is 4° or 6° Brix. and the temperature is between 100° and 105° Fahr. With ample water for cooling, coils could be installed in the fermenter and the mash started at a temperature around 90° Fahr., this temperature being maintained throughout the process.

The French fermentation system comprises one or two main fermenters, feeding to a row of smaller ones equivalent to one-half the capacity of the main tanks, but which would represent the daily capacity of the plant. In the main fermenter a full mash would be stocked one day; on the following day one-half its contents would be run into the smaller tanks, and these would be allowed to work down to the end point of fermentation. In the meantime, the main fermenter would be filled up again with freshly prepared mash, to be worked upon by the remaining actively fermenting half. Thus the process could continue throughout the season, or until the contamination and lost vigor would demand a new starter. The simplicity of this system is offset by the greater chances for loss due to errors or carelessness in manipulation.

When fermentation is complete, the "beer," as it is termed, contains from 7 to 10 per cent. of alcohol; it is drawn off for its first distillation through a pipe line which is connected to the bottom of each fermenter.

Policy

Before a selection of one of the two distillation methods is made a well-defined marketing policy must be worked out. Is the manufacturer going to serve the many industries, with their discriminating demands for alcohol, or will the public use it as an article of general utility and, as the more recent turn of affairs indicates, as a fuel for both motive power and illumination? Or will he divide his output in some predetermined ratio between the two?

In the first case he must be prepared to turn out several grades of alcohol. The highest quality is termed "silent spirit." It is odorless, tasteless and colorless. Chemically it contains acids, ethers, esters, aldehydes and higher alcohols in percentages that are in second, third and fourth places behind the decimal point. For this service he must select the discontinuous method of distillation, either to the extent of his full capacity or some fraction thereof. If, on the other hand, the manufacturer serves the fuel and general utility demand plus such of the industries as do not discriminate

so closely, he will install the continuous method with its material advantages of economy and with quality subordinated.

Distillation

Here the 7-10 alcoholic content of the beer is volatilized and concentrated to 50 or 75 per cent. strength, the residue being thrown away or else treated for by-product recovery. The estimation of the necessary still capacity is based upon the number of gallons per hour it will handle so as to distill off a day's run in from 19 to 21 hours.

The stills are made of copper or cast-steel; they range from 36 to 96 inches in diameter and from 16 to 40 odd feet in height. By rough calculation each 12 inches in diameter will evaporate 15,000 gallons of beer per hour. The still column is subdivided into 25 or 30 "heads" or "chambers." These heads are of two distinct types; viz., the fluted bell-capped type of the Barbet design and the lipped, perforated type with a baffle plate extending well across the head. A down-pipe emptying from the head above into a reservoir is on one side of this baffle, and on the other side is an overflow pipe; the height of this pipe above the head regulates the depth of the liquor to be carried.

A pump forces the beer first through an apparatus called the heater or economizer, which raises the temperature about 70° F. when it enters the still column at the nineteenth or twenty-second chamber. As it circulates from one chamber to the other, its alcoholic content is thus evaporated by the ascending heated vapors. In the bottom chamber there is a perforated steam manifold connected with the exhaust steam line (wherever obtainable) and this in turn is fortified by a steam line supplying live steam direct from the boilers. As the steam ascends the still column it becomes richer and richer in alcohol, when in the 5 or 8 chambers at the top the strength is raised to nearly 75 per cent. The dealcoholized residue leaves the still from the bottom chamber through an automatic butterfly valve, which maintains a constant level of liquor therein. Naturally, this method of distillation causes a pressure within the still column which varies between $2\frac{1}{2}$ to $3\frac{3}{4}$ pounds and brings the temperature of the liquor in the bottom chambers up to 220° F.

The vapors after leaving the top chamber are conducted through the heater or economizer counter-current to the cold beer. From here they go through another similar apparatus counter-current to water for the purpose of further purification or concentration and then into the final condenser for cooling to a liquid. From the condenser the liquor goes through a testing box and into one of the several receiving tanks.

The operation of this apparatus demands conscientious service on the part of the still-runner. His indicators are the pressure gauges on both the steam supply and within the still itself, the size and strength of the alcohol stream at the test-box and a testing apparatus to detect any alcohol that might be remaining in the residue when it reaches the second chamber from the bottom. The distillate from this operation is termed the "high-wines." It must be refined and concentrated for the various commercial uses. This, with the redistillation process, is known as the discontinuous system of distillation.

Continuous System

The continuous system takes the vapors direct from the beer-still column and proceeds to refine or fractionate and concentrate them, turning out the finished

product in one operation, thus showing a decided economy of operation over the other system through lower consumption of steam and condensing water. The best designed apparatus for this method of distillation is probably that of Emile Barbet, of Paris, France. Several firms in this country have his manufacturing rights.

Rectification of the Second Distillation

During the fermentation process, aldehydes, ethers, esters and higher alcohols are produced as side reactions therein. These are distilled over with the high-wines and impart the characteristic odor and taste of whatever raw material was employed. Therefore, the object of a second distillation is to both dehydrate or concentrate the high-wines and to fractionate out these products of the side reactions. To accomplish this end the high-wines are washed with pure water to 50 per cent. strength; they are then treated chemically and charged into the kettle or pot. The kettle or pot is merely a tank, either cylindrical or horizontal, fitted with sufficient steam coils (not perforated) to evaporate the full quantity of liquor in each charge. Because of the low boiling temperature of the high-wines exhaust steam, besides being economical, is more efficient for fractionating. The vapors from the kettle or pot are conducted into the first head of the fractionating column and receive successive washings, boilings and condensations in the thirty to thirty-five chambers. These are of the Barbet fluted bell-capped type.

According to their diameter and height these apparatus have a running capacity of from 100 to 600 gallons per hour. The first distillate to come over at the test-box from each charge is very rich in the aldehydes, esters and ethers. As these are boiled out the alcohol becomes purer and finally a silent spirit results. Between 70-80 per cent. of the charge can be turned into this grade, the other 20 to 30 per cent. being equally divided between a second and third grade of alcohol of lower purity. To do this, the still must be run at a slower speed than when quality is no consideration; in which case the still can be run at full speed, such as will maintain the desired strength or concentration.

The vapors are condensed and run through a test-box and then a manifold, where it is diverted to any one of the receiving or denaturing tanks.

Receiving and Denaturing Room

This room is situated close to the still house, from where the finished alcohol runs through continuous and closed pipe lines, by gravity where possible, into cylindrical tanks fitted with gauge glasses and gauge boards.

The alcohol is measured therein; then the required amount and variety of denaturing materials are figured out and run into the alcohol, through pipe lines connected to the denaturant storage tanks overhead. There are two kinds of denatured alcohol, completely denatured and specially denatured. The former can be sold to the general public without any governmental restrictions; the latter can be sold only to manufacturers who are properly bonded and have obtained a permit to receive this alcohol, which has been specially denatured to comply with the various processes of their manufacture.

Distribution

The shipping facilities should be located in the same building as the receiving and denaturing tanks; in fact,

it should be the same room, save that the receiving tanks are partitioned off by a sheet-steel curtain door lockable for governmental supervision. Drawing-off manifolds are fitted to the tanks, permitting the filling of barrels or drums with ease and rapidity. Weighing scales must be provided for first tarring the empty packages and again weighing them when they are filled. Where the volume of business warrants, tanks and tank-scales should be provided for handling tank-car shipments. In this case the denatured alcohol is pumped to the tank scales, weighed and pumped directly into a tank car on the railroad siding, or else into other specially provided tanks for storage until tank cars can be spotted.

Ether Production

Should alcohol be manufactured with the main objective of marketing as a motor-fuel, a portion of the output could be converted into ether for admixture with the remaining portion of alcohol, producing an effective fuel. For this purpose it would be necessary to install an etherification unit and a selection can be made from one of two types of apparatus. Either the Barbet tower type, which also would be adaptable for the manufacture of ethyl acetate or other ethyl esters, or else the cylindrical vessel type, 5½ feet in diameter by 6 feet in height, with a capacity for 7,050 pounds of 66° Bé. sulphuric acid and 3,300 pounds of alcohol of 95 per cent. strength.

After the reaction is started a further supply of alcohol is added in a continuous flow so regulated that the volume of mixture remains constant. The reaction takes place between a temperature range of 374°-392° F., the heat being supplied through lead-lined coils in the vessel. The vapors from this vessel are passed through a neutralizing tower or column, where the excess acid is removed by a soda solution or milk of lime, and then redistilled in one of the alcohol columns previously mentioned, where they might also be combined with the alcohol vapors to produce the ultimate product—a motor-fuel.

By-Products Recovery

The residue from the beer stills is material rich in possibilities for the production of a very valuable line of chemicals or fertilizers. By simply liming and evaporating in a triple or quadruple effect evaporator, it yields a 32° Bé. magma. This is marketable as a fertilizer, based upon its ammonia and potash content.

Also there are two fermentation processes to which this residue may be subjected, yielding, in the one case, greater quantities of nitrogenous products, through the fixation of nitrogen from the air by the action of selected strains of bacteria, and in the other case setting up a fermentation which yields fatty acids, acetic, butyric and propionic, depending upon the time, temperature and bacteria employed in the fermentation process. The acids combined with ethyl alcohol are converted into very valuable solvents demanded by many industries or else suitable for admixture with the motor-fuel.

A plant operating at a daily capacity of 10,000 gallons of molasses should turn out 1,125 gallons of ethyl acetate, 440 gallons of ethyl butyrate and 3,125 pounds of potash as K_2O .

Conclusion

When the raw sugar industry receives a nominal price of \$5 per ton for its blackstrap molasses, it is sacrificing \$15 worth of fertilizer ingredients, \$20 worth of motor-fuel, charging it at 30 cents a gallon, and \$14.50 worth of chemicals. With ready markets

for practically all of these products it seems natural that it should turn its attention to the most advantageous utilization of this trade waste, either by installing independent manufacturing units, or forming a co-operative and central association for this purpose, much along the same lines successfully worked out by the fruit and nut growers of the Pacific states.

The cost of construction and management of an alcohol plant should not be so great as to be beyond the means of the industry. The years of 1919 and 1920 have been full of opportunities to secure excellent material and equipment for immediate delivery, by discriminating purchases of the used equipment left over from munition production.

By calling in the aid of technically trained engineers any of the slight local difficulties could be ingeniously overcome. While the description of the various processes as herein set forth are general, there are many modifications which could be adapted to individual cases with excellent results.

With the establishment of industrial alcohol manufacture the Island sugar interests, besides increasing their own profits, could take a step in the direction of economic independence of other countries and at the same time conserve their own agricultural resources.

Besides the various grades of alcohol the following list of commodities could be produced with slight readjustment or addition to the alcohol manufacturing equipment: Ethyl acetate, butyl acetate, amyl acetate, glycerine, butyl alcohol, amyl alcohol, yeast, carbonic acid, nitrogenous and potash fertilizer and acetone.

The present cost of manufacture of a gallon of alcohol should be substantially cut if the alcohol plant be located adjoining the centrales so as to utilize all available waste heat, thus cutting down the amount of fuel that otherwise would have to be imported. A noted professor of chemical engineering gives the estimated cost of production of a gallon of alcohol from sulphite liquor waste at 11 cents. This figure might be cut in half or more under favorable conditions.

The Nitrogen Catechism

An Economic Survey of the Nitrogen Fertilizer Situation in America as Relates to Production, Consumption, War Preparedness and the Addition of Government to the List of Producers and Distributors of Ammonium Sulphate

THE Merchants' Association of New York, Wm. Fellows Morgan, President, has addressed an appeal to the business organizations of the United States in condemnation of Senate Bill 3390, which provides for the government operation of Muscle Shoals Nitrate Plant No. 2 in peace-time for ammonium sulphate production for the alleged benefit of farmers.

The statement characterizes the project as a vicious socialistic enterprise and the bill, cleverly disguised as something to benefit the farmer by furnishing cheap fertilizer, as an agricultural sheep's skin covering a socialistic wolf. It is camouflage, concealing activities of two different groups of Muscle Shoals advocates.

The first group are the people who have for years been trying to get the government to build a water-power dam at Muscle Shoals. The second group is composed of certain radical farmer organizations, socialists and government operation enthusiasts, aided by a few conservative farmers who have been misled as to the scheme's real purpose.

Friends of the Muscle Shoals scheme realize that this is the crisis of their effort; they have worked on it many years. They have been, and are still, exerting every possible pressure upon Congress to advance their proposals to a point from which it will be difficult for the incoming administration to recede.

To set forth the present technical situation as regards nitrogen in America, particularly as relates to the proposed operation of Muscle Shoals, the following questions and answers have been prepared:

It is claimed that operation of Muscle Shoals nitrate plant No. 2 will prove of great benefit to all the farmers of this country.

The entire production of Muscle Shoals, 220,000 tons of sulphate of ammonia per annum, if applied at the modest rate of only 50 lbs. per acre, would fertilize 8,800,000 acres, or about 2.4 per cent of the country's cultivated acreage (368 million acres). The other 97.6 per cent. could receive no benefit simply because there is not enough nitrogen produced at Muscle Shoals.

It is claimed that Muscle Shoals operation would increase greatly the country's production of crops, although more is heard lately about farmers reducing crop production.

It is very easy to figure just how much crop increase would result from using the Muscle Shoals production of nitrogen. Dr. J. G. Lipman, Director of the New Jersey Agricultural Experiment Station, estimates that 75 lbs. of sulphate of ammonia applied on an acre of wheat will increase the yield on that acre 5 bushels. At this rate one ton of sulphate of ammonia will increase the yield 133 bushels. The entire output of Muscle Shoals would, therefore, increase the wheat crop of the country about 30,000,000 bushels.

In 1920 the country produced 790,000,000 bushels of wheat. Therefore, the entire production of Muscle Shoals if applied on wheat would have increased the crop from 790,000,000 bushels to 820,000,000 bushels, or an increase of 3.8 per cent. While wheat is one of our important crops, it represents only 15.6 per cent. of our entire acreage of crops, so that the increase stated would amount to only six-tenths of one per cent. of our entire crop production.

It is claimed that Muscle Shoals' nitrogen would have farm labor on a great scale.

It would save labor to the extent that it produces an increase in the crop. It was shown in the previous paragraph that the total amount of the increase the entire output of Muscle Shoals could produce, would be equal to 3.8 per cent. of the total wheat raised, or 0.6 per cent. of all crops. It could save, therefore, only six-tenths of one per cent. of the farm labor as a maximum, from which would have to be taken out the labor of hauling and applying the fertilizer and harvesting the increase in crop.

Is there a shortage of nitrogen for fertilizer purposes in this country?

On the contrary there is a great surplus. During the year 1920 there was imported into the United States, up to the end of October, 1,300,000 short tons of nitrate of soda. It is estimated that the imports in November

and December will bring the total for 1920 up to 1,477,000 tons. The largest importations in any year before the war was in 1913, amounting to 701,000 tons. Since 1913 our consumption of nitrate of soda has increased from about 605,000 tons to 725,000 tons in 1920. Hence, in 1920 we imported more than twice as much nitrate of soda as we consumed, and this enormous surplus of nitrate is now in this country trying to find a market.

The price has declined from \$3.50 per unit ammonia in January, 1920, to \$2.90 per unit ammonia on February 1, 1921, still the nitrate is not moving into consumption. By-product coke ovens enormously increased production of sulphate of ammonia during the war. In 1914 the country produced 192,000 tons of sulphate, which was not enough to meet the demand, so that it was necessary to import 89,000 tons. In 1920 the domestic production was three times as large as in 1914. It is estimated that the equivalent of 500,000 tons sulphate of ammonia was produced in 1920. The consumption was about 320,000 tons; 120,000 tons were exported to foreign countries, leaving a surplus of 60,000 over consumption and exports. If Muscle Shoals were operated it would produce an additional surplus of 220,000 tons.

It is said that cheap nitrogen would create a new and large demand.

As an abstract proposition this is true, but it does not concern Muscle Shoals. Muscle Shoals nitrogen *cannot* be produced, sold and distributed at a price low enough to revolutionize the demand. The War Department's estimates of cost of production raise some doubts whether the plant could produce without losing money at present sales prices, and the War Department's estimates do not include taxes, depreciation, selling and distributing expense, items that by no means can safely be ignored. As far as cheap nitrogen is concerned, in the sense of nitrogen greatly below present prices, Muscle Shoals has no relation to the subject.

While recognizing all the advantages of an abundant supply of cheap nitrogen, it must not be overlooked that the whole output of Muscle Shoals could fertilize only 2.4 per cent. of the country's cultivated acreage, and it could not furnish even this meager quantity at any substantially lower price than the plentiful supplies of nitrogen now on the market. At present prices the supply is greatly in excess of the demand for fertilizer nitrogen, and Muscle Shoals could not offer inducements that would increase demand.

Could Government nitrate be sold and distributed successfully among farmers for home-mixing or straight application?

No practical organization exists or can be conceived which successfully could distribute 220,000 tons of sulphate of ammonia among farmers at reasonable expense. The sellers of the domestic production of sulphate of ammonia have conducted propaganda for many years to encourage the direct use of sulphate of ammonia, yet the sales to farmers are only 5,000 to 6,000 tons per annum. The U. S. Department of Agriculture, which had 100,000 tons of nitrate of soda for sale to farmers in the spring of 1920, at a price of \$89 per ton, succeeded in selling only 64 tons out of the 100,000. This was sold as follows: 48 tons to a chemical company and 16 tons to 11 other purchasers, of whom, judging from the names, 9 were farmers.

Is sulphate of ammonia suitable for home-mixing?

Sulphate of ammonia, when used in an ordinary fertilizer mixture containing acid phosphate, produces such

a severe hardening of the mixture that it can be used only after being ground in suitable machinery. This is the reason why home-mixers, as well as the small dry mixers (fertilizer companies) do not use sulphate of ammonia. It is used only by the large fertilizer manufacturers who have suitable equipment for grinding hardened mixtures.

To what extent will farmers benefit from cheap Government sulphate of ammonia sold to fertilizer manufacturers?

The 1914 Census of Manufacturers shows that sulphate of ammonia makes up only 6 per cent. of the total value of all fertilizers produced in 1914. If Government sulphate were sold at two-thirds the normal price of sulphate, it would result in reducing the farmers' cost 2 cents on a dollars' worth of fertilizer. What guarantee is there that a saving of cents, that the manufacturer made on Government sulphate, would be passed on to the farmer?

What farmers would enjoy the 2 per cent. saving on fertilizer containing Government nitrogen, assuming that the saving would be passed on?

Statistics of fertilizer consumption show that 95 per cent. of all fertilizer used in the United States is consumed east of the Mississippi River and 75 per cent. is consumed in the states which border on the Atlantic Ocean from Maine to Florida. Therefore, if all fertilizer manufacturers were treated alike by the Government the farmers in the Atlantic Coast States would receive 75 per cent. of the benefit of the Muscle Shoals operations. These farmers using fertilizer in the Atlantic Coast States make up 18 per cent. of all the farmers in the United States. They cultivate 11 per cent. of the tilled acreage in the United States. Of the 11 per cent., about one-third to one-half is fertilized each year.

It goes without saying that the Government's expense of operating Muscle Shoals would have to be carried by the farmers of all the states in the country.

Can sulphate of ammonia replace nitrate of soda in fertilizers?

Normally, fertilizer manufacturers use about 150,000 tons of nitrate of soda and 150,000 tons of sulphate of ammonia per annum in mixed fertilizers. Nitrate of soda is plant food in pre-digested form, ready for immediate absorption and assimilation by the plant. Nitrate, therefore, is always used in fertilizers that are to be applied early in the spring, before the ground is thoroughly warmed up. Ammonium nitrogen cannot be directly absorbed and assimilated by plants. It must first be converted to nitrate by bacteria. The bacteria, however, are not active until the ground becomes warm.

Therefore, sulphate of ammonia does little good until about a month or six weeks after planting of the crop. Nitrate nitrogen and ammonium nitrogen, therefore, as actually used in mixed fertilizers, do not compete with one another at all. The nitrate supplies plant food to cover the period from the day of planting to 4 or 5 weeks later, when ammonium nitrogen begins and carries the plant along for another period of six weeks or two months.

To what extent can sulphate of ammonia take the place of organic nitrogen?

Organic nitrogen is much slower in action than sulphate of ammonia. It becomes available at about the same time after planting as sulphate of ammonia, but it usually lasts about again as long, namely, 2 or 3 months. If we considered nitrate of soda the break-

fast of the plant, and sulphate of ammonia the noon day meal, then organic nitrogen represents the afternoon lunch and supper of the crop.

Sulphate of ammonia has always been a great deal cheaper than organic nitrogen. On an average, a unit of ammonia as sulphate of ammonia costs only about 70 per cent. as much as a unit of ammonia in organic form, or in organic materials. Therefore, manufacturers have always tried to use just as much sulphate of ammonia as they possibly could, in order to reduce their costs of manufacture.

There are two reasons why manufacturers cannot extend their use of sulphate of ammonia per ton of mixture above the present practice. (1) Sulphate of ammonia, as stated before, causes hardening of the mixtures and, if carried too far, makes grinding difficult and the product has a heavy compact earthy feel that is objectionable to consumers. (2) Farmers have a strong preference for organic forms of nitrogen based upon country-wide experience over many years. It is possible that the better action of organic materials is connected with present methods of application of fertilizer. Changing of farmers' practices, however, is always a slow and costly undertaking.

To what extent can sulphate of ammonia displace nitrate of soda for industrial purposes?

Of the 725,000 tons of nitrate of soda consumed in 1920, 465,000 tons it is estimated were consumed for industrial purposes, such as the manufacture of nitric and mixed acids, manufacture of black powder, manufacture of sulphuric acid and for miscellaneous uses, such as glass manufacture and various oxidizing purposes. Of the 465,000 tons of nitrate so used, not one ton could be displaced by sulphate of ammonia. Sulphate of ammonia or ammonia gas could indeed be converted to nitric acid or nitrate of soda, and so displace nitrate of soda, if consumers were willing to pay the cost. To produce nitrate of soda at Muscle Shoals would cost, it is estimated, about 50 per cent. more than to produce sulphate of ammonia, whereas Chilean nitrate of soda normally sells at about the same price per unit as sulphate of ammonia.

It is claimed that Muscle Shoals will help make the United States independent of Chilean nitrate of soda in case of war.

The importation and production of nitrogen in the United States in the war year 1918 was equal to 2,060,000 short tons of sulphate of ammonia. The Muscle Shoals plant has a capacity equal to 220,000 tons sulphate of ammonia or 10.7 per cent. of our war rate of consumption.

The domestic by-product coke-ovens have a capacity equal to 500,000 tons sulphate of ammonia or 24.3 per cent. of the war rate of consumption. To be independent in case of war and have as large a supply of nitrogen as we did in 1918, it will be necessary to build six more Muscle Shoals plants, or to let the by-product and other private plants develop.

The present by-product ovens will not go out of business under government competition, because their only expense of operation, now that the ovens are built and paid for, is the cost of the acid and labor required to catch the ammonia set free in the coking operation. They can and will meet any price that the government will offer its product at, and will in fact probably sell below the government price. A low price, however, would mean decreased profits on the oven investment. Decreasing the profits will decrease if not entirely prevent the building of new ovens, since the purpose of investing money in by-product ovens is to make a profit, and if the profits are taken away there will be

no incentive to build new ovens. Government competition is not the way to encourage the growth of the by-product industry.

Is the completion of the Wilson Dam a war preparedness necessity?

The dam is not at all necessary for operation of Nitrate Plant No. 2 for war purposes, as this plant as its own steam power station with capacity to run all departments at 100 per cent. operation, and have power to spare. In other words, U. S. Nitrate Plant No. 2 is a complete unit and requires for its operation only coal, limestone, coke and minor supplies, in order to produce the produce for which it was built, namely, ammonium nitrate explosive.

Will the Muscle Shoals plant be obsolete 10 or 25 years from now?

The plant can be preserved in its present condition practically indefinitely and will be just as efficient for ammonium nitrate manufacture 25 years from now as it is today. More efficient processes than are known today may in the meantime be developed, but that will not diminish the operating efficiency of the Muscle Shoals plant. The fact that Muscle Shoals might not in the case of war be able to produce quite as cheaply as some process yet to be discovered, would not decrease its present ability to produce ammonium nitrate.

Employment Contracts in an Period of Retrenchment

UNDER New York decisions it has been frequently held that an employment at a specified rate per year is not an employment for a year (148 N. Y., 117; 204 N. Y., 525), but when the employment is for a definite term of a year or longer, at a specified rate per year, it will be upheld and an employee whose services are dispensed with before the end of that term can recover for services for the period engaged (216 N. Y., 591).

If the employment was in pursuance of a contract for two years, and is evidenced by some note or memorandum in writing, subscribed by the party to be charged therewith, or his lawful agent, it will constitute a valid contract and not a contract made void by the Statute of Fraud (N. Y. Pers. Prop. Law, Section 31), but if there was no written evidence, as by a letter offering employment, or otherwise, the contract is void under the same Statute of Fraud which requires as a condition precedent to recovery in event of violation, that all contracts of employment for a period longer than one year to be in writing. When made to be performed within a year, a verbal contract will be upheld, 176 N. Y., Supp. 276, but otherwise, if the contract is not to be performed within a year (13 Wend. (N. Y.), 307; 174 N. Y., Supp. 762).

The Allied Chemical & Dye Corporation will increase its common stock of no par value from 2,143,455 shares which it was authorized to issue under its certificate of incorporation to 3,143,455 shares. The preferred stock of \$100 par value will be increased from 373,264 shares to 973,264 shares. Provision also will be made for the addition of \$65,000,000 to the \$48,043,675 as the capital with which the corporation will do business.

These changes to be effected at a special meeting of the stockholders at 61 Broadway, New York, on March 7, are for the provision of an adequate reserve of authorized stock to be available for future issue as required without the necessity of repeated proceedings for successive stock increases in smaller amounts.

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A Consolidation of
The Chemical Engineer
and Chemical Age



ASININE is the attitude and foolish are the fears of those who see in a desire struggling for expression for economic organization among chemists a menace to the peace and tranquillity of the chemical industry.

Organization is an instrument of education. Those who would discourage it, to that degree not only retard the growth of the individual, but display their incapacity to see its place and power in progress.

Precedents in every profession are meaningless to those who would preserve a hierarchy that ignores the utilitarian.

The movement lags because of the lack of a leadership and an instinct for service that have made the American Association of Engineers the most virile agency for the professional progress of American technical men.

BY erosion from the peaks of skill are the valleys of the alert made more resourceful.

For one who assumes to be a teacher and a leader not only to hold up to ridicule and scorn a commercial practice that has its sanction in natural selection, but to impeach the Americanism of an organization than which none has surpassed in service to the nation, serves both as a confession of his inexperience in the practical procedure of production and to make the wise ones wink.

Making goods to sell is paramount to the sensibilities of any set of workers. The object of industry is service quickly and at a profit. Skill like the inanimate ingredients of a product flows where it is most needed.

The display of professorial impracticality in condemning a procedure of which industry everywhere is full of precedents casts reflections upon the quality of the advice.

The expedient of the du Pont organization in enlisting the skill of a couple of German chemists in a field

wherein American experience admittedly is backward, is commended as a sensible step by every one who has any practical experience in production management.

RECOVERY from the stagnation that everywhere confronts industry, which we were assured awaited only the completion of the deflationary process, appears to be not only indefinitely deferred, but to be a complicated process in which work all the contradictory inconsistencies of human nature expressed on a nationwide scale.

Raw materials felt first the reduced demand resulting from the revulsion toward war-time prices and sought distribution at lower levels determined by the proportion of the human element of cost. These reductions have not to any notable extent been passed on to the consumer.

From reduced consumption flowed non-production with unemployment which in turn adds to its immediate cause. Rather than accept generally a lower wage rate that industries might be kept in operation on a basis of product prices that would encourage consumption, labor suffers unemployment, and unjustly so because the reductions in the raw materials of labor have not been passed on to it.

In the endeavor to obstruct the natural flow of economic change that equilibrium may be established in the equivalence of the purchasing power of every man's dollar no particular group or class is exempt.

The penalty for violation of economic law is pervasive in its operation and cannot be confined to those most conspicuously the culprits.

THE metallurgy of iron and steel and the mining of coal are the fundamental industries, for they support and contribute essentially to all human activities.

In the following table are contrasted the fluctuations in the value of the products of these two industries with those of an industry whose members make up 46 per cent. of the total buying power of America.

Material	Pre-war Months 1914	Close 1919	Close 1920	% Decline During 1920
Steel Billets—Pittsburgh.....	\$20.50	\$48.00	\$43.50	9%
Pig Iron—Pittsburgh.....	13.75	36.00	33.00	8½%
Wheat No. 2, Red—Chicago..	.92	2.16	1.73	20
Corn—Chicago	.67	1.45	.68	53
Oats—Chicago	.39	.82	.47	43
Rye—Chicago	.63	1.83	1.56	15½
Rice—dones, New York.....	.055	.125	.0525	58
Flour, spr. pat., New York..	4.65	14.00	9.00	35%
Steers, top—Chicago	8.75	14.50	9.00	38
Hogs, live—Chicago	8.20	14.25	9.50	33½
Linseed Oil—New York.....	.54	1.87	.80	57
Cocconut Oil—New York....	.115	.19	.1175	38
Cotton—New York	.132	.3925	.1475	62½
Wool, scoured—Boston.....	.55	1.50	.68	55
Rubber, latex—New York....	.60	.525	.16	70
Coal, bit.,—Pittsburgh.....	1.30	2.35	3.75	Inc. 60
Petroleum—Oklahoma	.85	2.75	3.50	Inc. 27

Can you mention two factors that are exercising greater power to prevent the resumption of normal activity?

Can industry be maintained on a basis that denies to the producers of raw materials a price that will permit them to buy the products of industry?

A general resumption of industry cannot be predicated on conditions such as this table illustrates.

HUMAN though it may be to resist the influences that work apparently to one's discomfort, the labor cost of production must submit to its proportionate deflation if production is to be resumed on a scale commensurate with our normal needs and the individual interest really served.

We see in one great industry the wage rate preserved as a matter of policy because of a belief of its chief that the economic orbit of the nation can be adjusted to a condition that will involve the least annoyance to the industry—that prices eventually will adjust themselves to a wage rate, meanwhile tribute is levied on the world for everything made of iron.

In what has been stigmatized as the worst functioning industry and whose product is basis of all industry, we find in a period of complete deflation of the raw materials of sustenance and clothing, a positive increase of 60 per cent. in cost in the primary market.

In transportation we see the wage rate maintained by the organized power of the worker on a level that puts in the shade the pay of the professor—a heritage of the capitulation of government to class power.

If industry is to function and the needs of man be met, no element of production cost can hold itself aloof from the influences that determine selling price.

WE see industries clamor for tariff protection that do not produce sufficient for American needs and which if appeased only would oppress the consumer.

Labor demands that the stream of consumable goods flow unvexed of its added increment, but resists reduction of wage rate to the extreme of unemployment.

Industries ask for a tariff duty to protect American labor when the only result will be a situation that will aid a foreign competitor in a common market for that surplus that determines stable domestic production.

If recent and present experience teach anything it is the essentially co-operative and integral character of industry, that the personnel of each is the consumer of the products of the other and that no one element or industry can escape the play of forces to which all are subject without disturbance to all and its share of the common injury.

Specialization which is the basis of our industrial civilization has created an intolerance and a sulkiness to group adaptation to the common welfare that can be overcome only by an appreciation of group responsibility for the common service. Meanwhile business languishes until the lash of necessity and public opinion inculcates the proper moral attitude.

HERBERT HOOVER in his remedial suggestions for the elimination of industrial waste itemizes the many elements of inefficiency in national production and attributes a just responsibility to the technical man for their correction.

Progress is increase in efficiency. Just as function precedes structure in biological development, so the refinements of civilization come just as fast as the people can assimilate them.

Elimination of industrial waste is a function of education. While its factors in our material civilization are technical men, the initial impelling force is an aroused public sensibility to its existence as a deterrent of efficiency, for in goods, prices and treatment, commercial or governmental, people are given what they are satisfied with.

Industry as we commonly refer to it is only one part of the general activity and, while of powerful influence upon the whole, many of its deficiencies arise from the awkward functioning of our economic system which, happily, continually is growing in grace.

Can we not say of an industrial system as has been said cynically of government that people have the kind they need or deserve?

PRODUCTION inefficiencies will persist so long as the people are satisfied to pay their costs.

With growing wants, incident to education, has come the recognition of the evils associated with their satisfaction.

Just as many of these evils have arisen out of industry so the people look to industry to correct them.

Where industry is most derelict in its responsibilities in this respect there we find most active that experimentation with the tools of production by those most ignorant of their character.

Organized industry in its capacity as the servant of society owes the double duty to itself and to its master, to keep its house in order and responsive to the needs of an advancing standard of living which is based primarily upon an increasing volume of better goods at prices that encourage at once consumption and production.

That industry shall function uninterruptedly and with increasing efficiency is the primary concern of society.

GOVERNMENTAL interference with private industry, beyond its legitimate obligation to provide equality of opportunity, arises almost invariably from abuses and takes the shape of the people seeking to do themselves the work of the servant with results that are the common experience of everyone who seeks to do that for which he is not qualified or intended.

The most powerful and effective agency for the correction of misdirected or ill-coordinated energy in modern society is publicity.

The correction of abuses by government control of private initiative is a remedy fatal to the servant and injurious to the master.

State Legislation and Carbon Black Manufacture

A Study of the National Service of the Carbon Black Industry and a Call for Circumspection in State Legislation That Would Imperil That Service

By A. F. Kitchel

VARIOUS articles have appeared recently in the daily press with reference to the situation which is now confronting the producers of carbon black in this country. It will be to the interest of the readers of CHEMICAL AGE to have this matter thoroughly explained in detail, so that a true conception may be had of the facts in the case.

Laws restricting the use of natural gas in the production of carbon black have been passed in the State of Wyoming which have practically stopped the production of this important material in that state. It is now considered probable that similar laws will be brought up for passage before the Legislatures of Montana and Louisiana along the same lines, and it is claimed that the industry in these states likewise will be killed if the pending legislation is enacted.

Carbon Black

Carbon Black is the name commercially applied to an amorphous form of soft carbon, produced by the combustion of natural gas. It must not be confused with lamp black, which is a black manufactured by the burning of oil. As a matter of fact, carbon black and lamp black are distinct products, differing from each other in molecular structure, tinctorial strength and other properties, and for the most part, in their industrial uses as well.

The distinct qualities of the natural gas product, carbon black, are its lightness, fineness, freedom from hard or gritty particles, miscibility in oil, intensity of color and remarkable coloring power when mixed with oils or other substances. No other black possesses this combination of properties. Carbon black is made only from natural gas. It cannot be manufactured commercially from any other substance. Theoretically, no doubt, it could be made from illuminating gas, but this would be impossible as a commercial operation on account of the low yield and prohibitive cost.

The business of manufacturing carbon black from natural gas is not an experiment, but an established industry which has been conducted in the United States for forty years or more. Its origin and growth have been coincident with the coming into general use of the modern printing press, requiring an abundant supply of ink adapted to rapid presswork. Carbon black, or gas black, is today a staple commodity as well known to the many arts and industries which depend upon it, as are aniline dyes or linseed oil.

There are altogether some forty carbon black factories in this country, located for the most part in regions remote from centers of population, and distributed among the states of Pennsylvania, West Virginia, Kentucky, Louisiana, Montana and Wyoming. These factories, with the wells and pipe lines that supply them, and the gasoline plants operated therewith, represent an investment of upwards of \$25,000,000. Carbon black ranks among the most useful of natural gas products. Indeed, its uses are such, that it may without exaggeration be said to minister in some form to the convenience and comfort of every citizen.

Carbon Black and the Diffusion of Intelligence

In point of time, the universal use of carbon black was connected primarily with the manufacture of news-

paper inks. Such inks are made by the admixture of carbon black and certain oils in the approximate proportion of one pound of black to eight pounds of oil. The resulting nine pounds of ink is sufficient to print approximately 2,250 copies of the average newspaper. In the year 1914, there were no less than 22,754 newspapers and periodicals published in the United States, employing 112,000 wage earners and having a combined circulation of 14,000,000,000 copies or 140 copies for each man, woman and child in our country. There were in the same year 33,471 printing establishments, employing 272,000 wage earners and having a product valued at \$643,000,000. More than 175,000,000 books and pamphlets were printed, of which at least 100,000,000 were educational or religious in character. These publications required annually over 100,000,000 pounds of printing ink.

The modern rotary press, which has come into general use during recent years, is now capable of 200,000 pages per hour, or over 50 per second. Manifestly the ink essential for operations of such rapidity must flow freely, possess great covering power and make an instantaneous and legible impression. For such ink, carbon black is the ideal and indispensable material. The National Association of Printing Ink Makers, which comprises most of the printing ink trade of the United States and is thus in a position to speak with authority, is responsible for the statement that without carbon black, "It would be impossible to continue the supply of ink requisite for the printing of newspapers." Mr. Ruxton, its president, himself a well known ink manufacturer, says:

"In the manufacture of newspaper inks, carbon black made from natural gas is an essential ingredient. No satisfactory substitute is available. Any restriction or curtailment of the output of carbon black therefore, presents the gravest cause for apprehension, not only to the ink manufacturers, but to the publishers of newspapers and to the entire reading public."

Carbon black is also a universal ingredient in carbon papers, typewriter ribbons and duplicating equipment.

Carbon Black and Short-Haul Transportation

Of great importance during the last seven or eight years has been the development of the use of carbon black in the manufacture of automobile tires, both solid and pneumatic. In 1920 there were 8,000,000 automobiles in the United States. It is estimated that the American tire manufacturers had an output in that year of about 35,000,000 tires. Taking these tires at an average price of \$25, the tire bill of the American people was in the neighborhood of \$800,000,000. The great majority of the better class of tires today carry black treads; in the manufacture of these tires millions of pounds of carbon black were employed.

Carbon black is used not for the sake of its color, but because it has been found that it adds to the toughness and resiliency of the rubber, giving better traction and much longer mileage. Tests conducted by the leading

technical experts of the rubber industry have demonstrated that carbon black added in certain proportions to their compounds gives an increase of 26 per cent. in tensile strength and 10 per cent. in elasticity. It also decreases weight, cost and time of cure, and, by retarding oxidation, prolongs the tire's useful life. Manufacturers who formerly guaranteed a mileage of from 3,000 to 4,000 miles are now making adjustments of black tread tires on a basis of from 6,000 to 10,000 miles. If only 10 per cent. additional mileage resulted from the use of black in these tires, it would mean a saving of \$80,000,000 in the tire bill of the American people for that year.

Miscellaneous Uses

These are by no means all the ways in which carbon black serves mankind. Other commodities in which it is an ingredient are paint, varnish, stove polish, crayons, waterproof coverings, cement colorings, composition goods and paper. During the war, millions of pounds of carbon black were supplied for the manufacture of tires for artillery and ammunition trucks, aeroplane tires, gas masks and camouflage material.

Carbon Black Manufacture Conserves Gasoline Production

Another feature of the carbon black industry is that it adds appreciably to the supply of high-gravity gasoline. Wherever practical, the factories are now equipped with absorption plants to extract every drop of available gasoline from the raw gas. Only the residue of gas remaining after such extraction is consumed in carbon black production; thus several million gallons of gasoline are added yearly to the nation's supply as an incident to carbon black manufacture. In most instances, the recovery of this gasoline would be otherwise impossible on account of the limited local demand and consequent inability to market the gas, after gasoline extraction, for other purposes. The gasoline so produced, according to the United States Geological Survey, represents a contribution to the gasoline supply of the country of far greater importance than its statistical position would indicate. On the one hand it represents a production of a type of gasoline that will fulfill the rigid requirements of motor fuel for aeroplanes in high altitude duty and also a type of high-gravity material that will blend with low-gravity naphthas to produce a desirable fuel for ordinary motors. On the other hand, the production of natural gas gasoline represents true conservation.

Production Efficiency

The process of manufacture is the most efficient that forty years of experimentation and experience have been able to devise. Chemists and engineers are employed constantly in research work connected with the various manufacturing problems.

One criticism often advanced is that, while there are said to be about thirty pounds of carbon in one thousand cubic feet of gas, only about two pounds of black are manufactured. But this criticism confuses the element carbon, with the commercial product, carbon black. The element is protean, existing in such diverse forms as the diamond, graphite, coal, oil, gas and the breath exhaled and in any kind of organic matter. The whole industrial value of the product, carbon black, lies in its unique form and properties. It is possible to increase the yield of mere carbon from gas. Many methods of doing so having been devised, but every one of them has thus far proved a failure, because it obtained quantity only

at the sacrifice of the qualities on which commercial value depends. Few human processes approach theoretical perfection, so that mere criticism of the carbon black manufacturer's process is not persuasive on this account.

Natural Gas Conservation

The carbon black companies are naturally vitally interested in the conservation of natural gas, upon which the continuance of their business depends. The processes employed are the best and most efficient that have been developed. If anything materially better, more economical or more efficient, were known, is it not reasonable to believe that the manufacturers would have adopted and put it into successful operation?

There has been published recently, under authority of the Bureau of Mines, a series of articles on the manufacture of this material. Nowhere is it suggested that any more efficient process has been developed or exists. If our process was obsolete or antiquated, or had been superseded by more efficient methods, is it probable that the Bureau of Mines would have suppressed or concealed the fact?

On the one hand, the carbon black manufacturers stand ready and willing to be of assistance in furnishing gas to local communities or pipe lines at a reasonable price. On the other hand, it is estimated by competent authority, that the sheer waste of natural gas in some of the states mentioned exceeds 150,000,000 cubic feet per day, or more than is consumed by the entire carbon black industry of the United States. This is real national wastage to which carbon black manufacturers naturally are opposed.

A State is the Trustee of Its Resources For the Union

The National Association of Printing Ink Makers in recent resolutions opposing any undue legislation against the use of natural gas for the manufacture of carbon black, in its preamble states:

We deem it unpatriotic for any one or group of states of our country to restrict their natural resources to the exclusion of the advancement of the rest of the Union, as were such a spirit pursued the state of Maine might prevent its wood resources from being used for the manufacture of paper, or coal-producing states prevent their coal from being used in other localities.

Other trade organizations are now taking up the subject and will doubtless protest against the proposed prohibition or serious curtailment of this industry in the other states.

A Fair Field and No Favor Insures the Maximum Common Benefit

All that the carbon black manufacturers ask is the right to continue reasonable use of gas from their own wells to operate their factories and the right to buy gas in the open market in fair competition with other industrial users. They do not think it un-American to ask the right to compete on equal terms. They do, however, call the attention of other enterprises to the danger of discrimination between manufacturers, whereby it might be established that one industry should have the right to buy gas whereas another should not.

Such laws despoil one manufacturer or class of manufacturers for the benefit of another. They suppress

competition in the interests of those favored. If, for example, manufacturers of carbon black and gasoline may be deprived of the right to compete in the production or purchase of gas at the instance of another manufacturer, may not this manufacturer in his turn be deprived of a like right at the instance of some different manufacturer and so on?

Is not the true principle that of equal opportunity

and open competition, which has long been the American policy to foster and encourage? The old fable of the body and its members has not ceased to be true. In the laudable desire to save natural gas in certain localities, we must not forget the welfare or convenience of the body politic as a whole. A saving would be too dearly bought if accomplished only at the inconvenience and detriment of the entire public.

Improved Centrifugal Separation of Oil from Soap Stock

By Arthur Delafontaine

SINCE the first oil was refined, gravity has always been the method of separating the refined oil from the soap stock, with the exception of the Baskerville process which requires the addition of certain materials of great absorptive nature to render the soapy mass porous so as to permit filtration.

The refining of oil as now generally done is a slow, expensive method, although some firms have devised novel methods to increase the yields such as jacketed cones to retain the heat in the refining kettles and special types of paddle agitators to pack the foots better. In conjunction with paddle agitators one of the largest oil refiners is getting excellent results much better than with the propeller type. A fact not generally known in refining circles is that the stirring is slowed down when the break first occurs to coagulate the soap stock better and give it a more compact form.

ting a clear oil, free from soap stock. After many experiments, I found that the addition of a small amount of soda ash at a specific stage of the refining process not only gave a clean separation, but that the oil was clean and compared very favorably with oil that had been washed and settled. On some oils another difficulty was to get the soap stock to stick to the sides of the centrifuge, and especially so with the cottonseed and corn oil. Of course, it is feasible to refine oil with soda ash to obtain a firm soap stock, but the color reaction is not anywhere as pronounced as with caustic soda refining. Therefore, I devised a way of refining, first, with caustic, using just enough to barely neutralize the fatty acids, and adding enough soda ash to form a firm soap, which acts instead of excess alkali.

The centrifuge I used first did not give a clean separation, and after many tests the machine as outlined in Figure 1 gave excellent results. The oil is fed from the refining kettle through a pipe (P) to the lowest part of the centrifugal machine. The bottom baffle (H) is arranged so as to prevent the oil from traveling in a direct trajectory to the outlet of the centrifuge, and the second line of baffles, B, to provide additional centrifugal action.

The revolving drum of a suitable centrifugal machine is shown in Figure 1 where A is the axis about which the drum revolves. The refined oil to be separated is fed into the drum by the pipe P, and passes under the ring H. The heavier soap stock is thrown against the sides, in space I, of the basket and the lighter in space F. The clear oil overflows at D and discharges through opening O into the bleaching kettle. After the sides of the basket are filled the machine is stopped, the oil remaining in the bowl runs through a suitable removable funnel to a small tank to which is connected a small centrifugal pump that returns this oil to the feeding tank of the centrifugal machines.

This is in reality a compound-acting machine, as the separation of the heavier soap stock is effected in the lower compartment and the lighter parts in the upper. The upper baffles are so arranged that they can be removed quickly and the whole operation of stopping, cleaning and re-starting again can be accomplished in ten minutes by an experienced operator. On several hundred of experiment runs the yields were from 1 to 6 per cent. better than by gravity. These experiments were run with batches of from 1,000 to 10,000 grams.

This method means not only a more rapid handling of oils, but permits of a more compact installation, as it is feasible to use a small refining kettle, a reasonable number of machines; and the finishing or washing tanks are eliminated. The oil from the centrifugal can be run straight to the bleaching kettles. One machine will hold 450 lbs. of soap stock before it has to be cleaned and can handle from 40,000 to 60,000 lbs. of oil per 24 hours. Patent has been applied for both on the process and the machine.

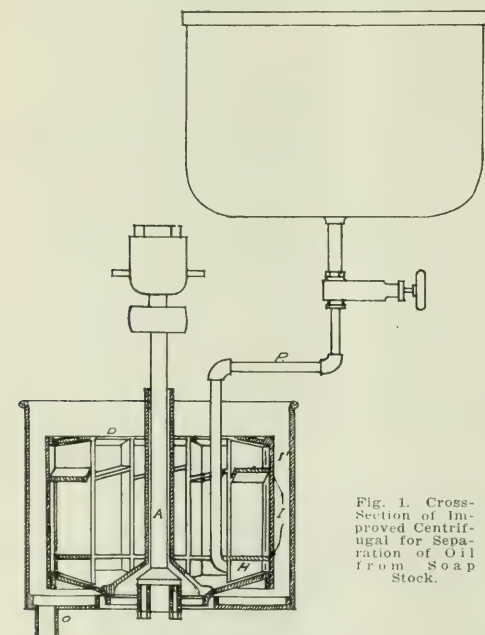


Fig. 1. Cross-Section of Improved Centrifugal for Separation of Oil from Soap Stock.

The idea of separating soap stock from oil with centrifugal machines occurred to the writer several years ago on reading articles on centrifugal separation in 1915-1916. At the first opportunity, I applied this method to separating oils from soap stock with an ultimate view, not only of increasing the yields and eliminating settling, but also finishing of the oil.

One of the main difficulties encountered was in get-

Automatic Control of Chemical Reactions

By Philip E. Edelman, E.E.

Consulting Engineer

TEMPERATURE, pressure, mass, time of reaction, etc., together with the human factor, impart to chemical reactions characteristics far removed from those of processes heretofore associated with automatic control.

The demonstration of the efficiency of automatic control of industrial chemical reactions opens a wide field for the elimination of the human variable and the introduction of standardized conditions that promise much for increased economy of production and independence of manual labor in many branches of chemical manufacture.

To commercial automatic indicators of fluid volume, of gaseous mixtures as the products of combustion, etc., are now added devices for the control of chemical reactions, which, attached to ordinary chemical equipment, maintain a constant quality of output with either continuous or batch operation.

Automatic chemistry, that is to say, a process controlled wholly by itself without the usual hand sampling, titrations, and manual manipulation is accomplished today with remarkable economical results. The continuous sampling and accurate indication thus afforded make possible in many cases continuous operation not only with greater economy, but with more satisfactory results than is possible by discontinuous or batch methods. On batch work the automatic electric device is independent of the guesswork of operators and instantaneous in stopping a treatment undergoing continuous changes exactly at the right point for maximum yield without overtreatment.

Procedure of Control

In this new electrical control system, chemistry is worked from the result back to the treatment and the actual chemical condition of the end-product self-regulates the treatment to maintain the standard set for. This result is usually accomplished by using the net compensated conductivity of the mix which when properly compensated for variables, temperature effect, and reaction conditions by patented methods, affords an extremely accurate electrical indications by patented methods, affords an extremely accurate electrical indication of the concentration. Appropriate electrical instruments are provided to exactly follow such indications in accordance with such compensated concentrations of the ions present in the liquor, thus replacing the need for color indicators and titration tests to show the strength.

The electrical indication is more sensitive and accurate than the best color-indicated titration affords, and the merest traces which entirely escape analytical determination can be shown thereby. Thus in cotton washing and in filtrates from filtering operations or in spent tailings the slightest trace of residual acidity or alkalinity or salt content now can be shown continuously.

One important application of the newly developed automatic instrument is in continuously recording on a chart-record the exact percentage strength of a solution or the acidity or alkalinity or concentration at any point in a process without any manual manipulation whatsoever. Such chart recorders can be conveniently located in the superintendent's office as a check on important operations.

Thus if the workman has been told to make up a certain strength of brine or to regulate electrolytic cells for a certain acidity, this chemical recorder shows whether it has been done or not. Workmen notoriously have been lax in making written records of plant operations and are often caught "fudging" records arbitrarily or writing up the whole day's report the last few minutes before going home, so that with the automatic recorder waste of valuable materials often concealed can be at all times accounted for.

Application in Pulp and Paper Industry

The new control system goes much farther than this, for by the use of highly developed auxiliary relays, pilot lights, safety appliances and automatic electric regulating valves, the net compensated conductivity is made to regulate automatically the treatment for a constant mix or end-product. A typical example which has been in successful commercial use since 1917 is at present working on large tonnages day and night in the paper industry in this and other countries. In this particular case, sulfur is burned to sulfur dioxide and absorbed either in a milk-of-lime or tower-system to form normal sulfurous acid with free sulfur dioxide gas for digester liquid. It is important to maintain the relative amount of combined and free gas standardized and this the Automatic Control does continuously within an accuracy of .005 per cent.

The electrodes are placed in the output liquor and continuously measure the strength. If for any reason either the sulfur dioxide or lime supply varies, this is instantly shown by the apparatus and self-corrected for as follows:

The chemical change causes a corresponding electrical change. Suppose there is too much free gas. The controller immediately opens the milk-of-lime valve wider, or water valve in the tower system. On the other hand, if the free-gas content falls, an excess of uncombined lime follows but the controller and electric valve immediately reduce the lime-feed to bring the result back to normal.

When the result is right the controller rests and the valve locks and holds its adjustment until something varies and again requires automatic regulation. Even if the valve partly clogs up from lime deposit the control functions, merely opening wider for the same result. The thing works accurately, and gives uniform acid, thus materially increasing the efficiency of the acid plant. There is no waste of gas, and lime-clogging troubles previously occurring from uncontrolled excess lime are avoided. Leakage in water-seals or flow-boxes is detected immediately by the electrical instrument, so that danger of shut-downs is avoided.

The various circuits used are properly interlocked and safeguarded so that there is no danger of shocks or burn-outs. Electrode troubles have been overcome and proper care of polarization, gas, deposits, insulation, has been accomplished in the design after long and tedious researches, so that the new equipment is practical for actual plant work.

Application to Equipment in Chemical Manufacture

Edelman automatic control units also have been applied successfully and are suited to a wide variety

of other chemical problems concerned with the production or use of chemicals, organic as well as inorganic. It works on all practical process temperature ranges for both good and poor conductors, also in cases where there are numerous variables, with few exceptions.

A very large amount of practical development work has been found that violent agitation, bubbles, chancical control to vacuum pan, still, autoclave and other batch operations as well as continuous processes. It has been found that violent agitation, bubbles, changing temperatures or pressures or vacuum are properly compensated for by the improvements incorporated in the apparatus so that only the actual chemical condition in the changing batch is indicated.

As result of improvements made in early forms of the Control, many problems previously thought impossible can now be handled. One instance is the case where conductivity determinations are impossible due to several different strengths having substantially the same electrical resistance, and this happily has been solved satisfactorily so that materials having very flat or variable curves can be handled by the Control.

Examples of Application of Automatic Control

Some of the principal types of chemical operations suited to the new production method afforded by this Control are (1) determination or control of strength of solution, (2) determination or control of concentration output from evaporator or other process step, (3) determination and control of amount of suspended solids in a solution, such as definite percentage paste compositions, (4) control of absorption of a gas in a liquid with or without a chemical reaction, (5) control of reaction of two or more liquids mixed together, (6) detection and prevention of entrainment losses by automatic reaction of liquid levels operated thereby, (7) control of reaction of a liquid with a pulverized solid, (8) general reagent mixing at will to particular strength from strong storage tank supply, (9) safe use of condensates and process drips for boiler feed by means of Edelman 3-way electric valve inch automatically by-passes all contaminated water to waste, (10) automatic changing of receivers for maximum yields from still processes, (11) automatic recording or control of end-point reactions for definite acidity or alkalinity, (12) automatic treatment of water supplies for elimination of undesired hardness or contamination automatically proportioned to variations occurring therein, (13) automatic maintenance of strength of treating baths in silk weighing, dyeing, tanning, etc.

With automatic control, chemicals of the highest grade can be prepared at much less cost than by old hand methods since unnecessary labor heretofore used for sampling and titrations with subsequent manipulation is displaced. Users of chemicals know that they seldom get two shipments of the same materials alike twice. This necessitates analysis of supplies and correction of formulas. With the new system however, the acids or alkalis or salts entering into the process are first brought automatically to proper standard strength, eliminating all further bother or waste, and insuring standard products.

The electrical attachment gives results on poisonous materials dangerous to human life; also on sticky and turbid materials and organic compositions which do not give satisfactory color indication. It is suited for the automatic maintenance of brines and electrolytes at correct condition for maximum yields. It has been applied successfully to automatic cooking to replace the

arbitrary skill of batch cooks who depend on variable individual tastes, color and light, with decidedly closer uniform results day in and day out. There is no limit to the size, type and number of valves which can be controlled automatically by this new interlocking method. Proper provision is made to prevent jamming of valves, burning out of circuits, or failure of supplies. All parts are thoroughly protected from moisture and corrosion. Power consumption is very small.

The importance of accurate control can best be understood from the fact that a matter of a few minutes lost in taking and determination of samples from a continually changing batch may make a difference in yield such that a product worth several dollars per pound is obtained or if too late, a by-product worth but a few cents per pound will be had. The automatic control does not have to wait but takes and determines samples instantly.

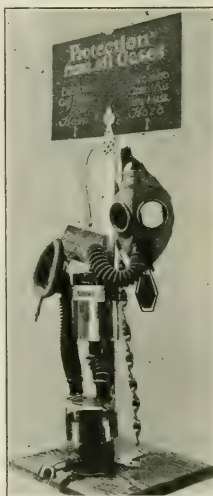
Demonstration of Gas Mask Efficiency

The safety movement in industry looking to the reduction of the waste of human life has emphasized, particularly in industries where workmen come in contact with noxious gases, or where by fire or accident poisonous fumes may be encountered, the importance

of the gas mask, or breathing apparatus as a readily available tool and an essential part of the plant's rescue equipment.

The manufacture of gas masks for warfare was a duty readily assumed by the American-La France Fire Engine Co., Elmira, N. Y., which made available its experience in the manufacture of industrial gas-protective devices. Gas masks are supplied to a great variety of industries in a form that admit of protection against more than 50 varieties of poisonous gases.

The efficiency of the gas mask to prevent the inhalation of ammonia fumes was demonstrated in recent public exhibitions by the equipment shown in the accompanying illustration where may be seen two outlets of the glass gas-chamber, one direct and one through the gas-absorbing canister. With the protective gas-mask air could be inspired through the ammonia-gas chamber and breathed safely, while a whiff from the direct outlet indicated the necessity of protective apparatus in an atmosphere thus charged.



Equipment to Demonstrate Efficiency of Gas Mask Against Ammonia Fumes

E. W. Wagy, superintendent of the Petroleum Experiment Station of the Bureau of Mines at Bartlesville, Okla., has resigned to accept the position of production engineer with the Standard Oil Company of California. H. H. Hill, who entered the Bureau of Mines as a chemist and who has been serving as assistant superintendent of the station, has been appointed superintendent.

Chemical Engineering and Economics in Shale Oil Recovery

An Outline of the Problems of the Shale Oil Industry

By Arthur J. Franks

Colorado School of Mines, Golden, Colorado

IT is not the author's purpose to panegyrize the chemical engineer. It is to point out his present and future role in the American shale oil industry that is to come and to indicate, for the success of his work, the mutual dependence of himself and the business man, that this contribution is made.

It is the general aim of industry to secure profit by increasing the utility of a thing through change of form, or by conversion of raw material possessing practically no intrinsic value into a product for which there is a demand.

Broadly speaking, this also is our purpose, viz., to convert the raw oil shale into products for which there will be a market, and to do so at a profit which will represent at least an ample return on the capital invested. When one considers how gaunt is our knowledge of the raw material itself and that comparatively little is known of the possible products which may be derived therefrom and even less of their character, the problems, each with its mass of detail, appear temporarily overwhelming and we are prone to question the sanity of those business men who think that all that is required to establish the shale oil industry are liberal capital, a well-organized company, and a "process."

While processes are indeed essential and are primary requirements for any successful enterprise, they are not sufficient in themselves. The "process" needs to be scrutinized more thoroughly than is the custom, due to the great variations in the initial material and the products obtainable from it. While the technical difficulties are numerous and profound, let it be understood at the outset that they are all soluble. After considering these problems we will be better qualified to determine whether the chemical engineer is entitled to a part in their solution, and if so, what it will be.

Problems of the Shale Oil Industry

The problems confronting the shale oil industry might be classified under two heads, viz., (1) economic and (2) technical. But, as will be seen later, these two divisions are so intimately articulated that a separation becomes illogical. Aside from the usual financial obstacles encountered in any industrial enterprise, our problem is of an engineering nature entirely and should be attacked as such. It is, however, capable of many divisions which are easily classified into three categories, only the first two of which will be here considered in detail:

- A. Carbonization of the Oil Shale.
- B. Refining of the Oils.
- C. Development and Utilization of the By-Products.

Although objections might be raised to a classification in which the by-products are considered last, it is nevertheless a logical and sound one. The author is fully cognizant of the fact that many industries owe their present sustenance to profits from by-products. Yet the establishment of an industry upon such an unstable basis is to court future disaster, because the demand for such materials frequently fluctuates greatly and some-

times suffers a sudden end. Examples of such occurrences are all too common to the chemical industries.

Oil products, on the other hand, are staple commodities for which there is always a more or less settled market; and hence, they should form the foundation and main superstructure of the shale oil industry. Once these are firmly established, the by-products will be welcomed as forerunners of certain expansion, and healthy growth. On the basis of this classification, then, let us outline the problems which confront us and suggest the methods of solution.

A. CARBONIZATION.

1. Chemical Research and Design

(1) Study of the character and properties of the raw material, the oil shale.

This involves physical measurements, proximate and ultimate analyses and analyses of the ash. From the results of this work may be deduced some of the general characteristics of the organic and inorganic material that constitutes the shale. Isolation and identification of the individual constituents would follow. However, it has not been possible up to the present time to perform either of these operations with any success upon the organic material of the shale. While much work has been done in this direction, no definite conclusions have yet been obtained. But it is certainly absurd to attempt to work any material without first securing all the knowledge possible concerning its composition and properties.

(2) Investigation of the properties and composition of all the different oils and other products which may be obtained by varying the conditions that obtain during the retorting.

The results of this research would lead to many generalizations concerning the effect of physical conditions on the properties of the products from the carbonization, which would serve to determine plant control later. The work necessary in this connection would consist of complete analyses of the shale carbonized and the gaseous, liquid, and solid products formed. An adequate record would have to be kept of the temperatures, pressures, size of shale, yields of oil, gas, and ammonia, and the rate of their evolution, heat supplied, and time consumed during the period of carbonization.

(3) A study of all possible uses to which the products might be adapted.

This would have to be made from the results obtained from the previous work outlined in No. 2.

(4) Testing the products to determine their adaptability for the purposes considered above.

Here many former possibilities would be eliminated and a definite choice of products to be manufactured would be made. The final decision would eventually depend upon the economical advisability of producing one article or the other. The possible price, local conditions, the market, the amount of machinery and apparatus which would be required, and many other variables would influence the final decision. This is, of course, obvious and needs no further elucidation.

(5) Determining the physical and chemical properties required in each of the products to be manufactured, and establishing standards of perfection to serve both as a guide and a goal in plant practice.

It may be necessary to establish entirely new sets of specifications for shale oil products, for while these have in some cases been found to serve certain purposes better than petroleum products, they fail to meet the specifications now accepted for the latter and are, therefore, looked upon with suspicion, which is evidently unjust.

It is also to be remembered that conditions attending the use of certain substances frequently change, while the specifications remain stagnant, or else lag far behind. Requirements are sometimes made which are of little or no value, as subsequent research shows. Still it is a fact that consumers of all commodities are reluctant to change their standards from what they habitually have considered as satisfactory or perfect. But a new industry demands new thoughts, new ideas, and new methods. The slaves of tradition can never make progress here. Only men of originality, initiative and courage need hope to triumph.

(6) Designing a small retort which will satisfy or closely approach the optimum conditions predetermined by the results of all preceding work.

This is really the easiest problem of all, once the other knowledge is available, and requires no particular genius for its solution. It is self-evident that a retort designed without a knowledge of the material which is to be carbonized, or in ignorance of the fundamental principles involved and the purpose aimed at, is doomed to ultimate failure. Only by the merest freak of chance could the proper machine be conceived in such a manner.

The required laboratory research will now be complete and it only remains to translate the results from the laboratory to a plant scale. These problems would be classed under the heading of

II. Mechanical Research and Design

(1) Design, construction and testing of the first commercial carbonizing apparatus to execute the optimum conditions predetermined by laboratory research.

This work must be considered as mere preliminary, commercial scale experimentation and not as that of permanent construction. In applying the principles discovered in the laboratory to a commercial scale, many difficulties are always encountered, and the results are frequently very discouraging. Numerous modifications and radical changes must often be made, and theoretical considerations sometimes sacrificed for the sake of simplicity, durability, and economy of construction, as well as continuity of operation. The ultimate result should be a "unit" retort.

(2) Design, construction and testing of the ultimate commercial retort and its accessory equipment.

For the solution of this problem are assembled all the results of previous researches and the best of engineering skill, in order that the final apparatus be as perfect as possible chemically, mechanically, and economically. Hence, a competent mechanical engineer should be charged with the design and construction work in cooperation with the chemical engineer. If the results of the test are satisfactory, the retort may be considered for the present, as finished.

As in "Carbonization" the refining problem also may be divided into the same two main parts, viz., chemical and mechanical research and design.

B. REFINING OF THE OILS.

I. Chemical Research and Design

(1) The development of processes for refining the crude oil into the products to be marketed.

Here must be considered the elementary results obtained in the previous researches and outlined in A-(1) and (2) and (5). Knowing the composition of the oil and the constitution and properties of its components, as well as the standards to be attained for each product, it is not a difficult matter to develop processes for removing the undesirables, or to determine what is lacking and supply it. The constituents which must be removed more or less completely in the refining are embraced in the following four classes of organic substances: a. Nitrogen compounds; b. Sulphur compounds; c. Oxygen compounds; d. Unstable unsaturated compounds. These all occur in shale oils in many different forms. A knowledge of their characters and properties obviously is essential to the ultimate solution of all refining problems. They are to be subjects for a number of papers now in preparation.

(2) Simplifying and perfecting the processes economically as well as chemically.

This often is the insurmountable obstacle past which many laboratory operations may not go. In order to be successful a process must not only accomplish its end, but must do so with but little effort and expense. Unless modifications can be made to secure reliable performance in this manner it is commercially useless.

(3) Adapting the process to large-scale manufacture.

This is also a difficulty that frequently is encountered. Unless the necessary procedure can be repeated economically with large amounts of material it is doomed to failure. Sometimes only a few modifications are required to attain this end; more often many changes are needed. In most instances it also is necessary to test the process on a small commercial scale before proceeding directly to large scale practice.

II. Mechanical Research and Design

(1) The design, construction and testing of the first commercial scale apparatus and standardization of the unit of production.

The same remarks made previously under this head apply here also.

(2) The design, construction and testing of the final apparatus which is to execute the conditions predetermined by the results of all preceding work.

The culmination of the exhaustive researches thus far outlined and completion of equipment design furnish the knowledge and instruments with which to begin production.

Economic Problems Stated

The problems yet to be considered are mostly economic, but their correct solution is very essential to the success of the enterprise. Since the details are more or less evident, as are the reasons reinforcing the suggested, general solutions, these problems will only be mentioned, for this is not an article on plant management.

1. Planning, or "laying out" the plant in accordance with scientific principles.

2. Choosing a suitable plant site and construction of the plant.

3. Installation of a clearly defined and simple system to guide plant operations and to promote efficiency.

4. Selecting a capable and loyal organization to operate and manage the plant. In this would be included

a division for chemical control and inspection of the raw materials and finished products to determine their conformity to set standards for quality.

5. The establishment of a capable and loyal research organization, whose purpose it would always be to strive for improvements in the processes and equipment, to discover new products and new uses for those already manufactured, and to decrease and utilize all plant wastes.

The founding of such an organization in connection with an industry means progress and success. When plant operation starts research actually begins, special attention now being given to

C. DEVELOPMENT AND UTILIZATION OF BY-PRODUCTS.

Former investigations were only preliminary as compared to what must now be done. But the studies which are to be made hereafter are to be executed under different conditions and with less handicap since the plant will now be operating and producing, and will, therefore, have income. The cost of further research can now be paid out of the returns on the products and should be considered as part of the regular overhead expense. This was not possible before.

It may be some time before the industry begins to pay appreciable dividends. But as time goes on, a firmly-founded and well-managed enterprise gradually expands and grows and the profits increase. Greater appropriations can now be made for future research, the main goal of which is more efficient utilization of products, by-products and wastes. The greater the

progress in this direction the greater will be the profit and success of the industry, and the greater the advance of our national welfare.

The picture of the shale oil problem is now practically complete. Can anyone be in doubt as to who is to play one of the two leading roles? We are concerned with transformations of matter, and this on a colossal scale. Determination of the nature of the matter, the new forms desired and the means of effecting economically these transformations summon the application of precision, honesty, efficiency, initiative, sound analysis and judgment and courage. It is the particular work of the chemical engineer, and he only possesses the attributes required for its successful accomplishment. Let those who believe otherwise turn to the failures of the past which have so discouraged many business and scientific men alike.

But after all, how is the chemical engineer to accomplish this stupendous task; and what is the value of its consummation? The mere achievement comes to naught unless it can serve the industry, and hence, promote the welfare of the nation. Such an attainment demands the hand of business, which is needed for the translation of technical accomplishment into industrial service. The great research problems require capital as well as knowledge for their solution, and further capital for the utilization of the fruits of their solution. Chemistry, engineering and the related sciences are only instruments which the business man must use in order to attain his end. Let him choose the right tools then, those with the best of temper, and let him use them well.

Some Items of Investment, Expense and Profit in Commercial Shale-Oil Production

By L. H. Sharp, Chemical Engineer, and A. T. Strunk, Accountant

Co-operative Oil Shale Investigation, U. S. Bureau of Mines and State of Colorado

THE receipt by the Bureau of Mines of inquiries from people of nearly every degree of business ability and experience as to the possibilities of profitably engaging in the manufacture of shale oil make advisable the publication of a general outline of the principal items of investment, expense and profit. Our aim is to aid those seriously interested and competent to engage in the industry and to impart information to those who have not considered the variety and scope of equipment necessary to commercial production of shale oil.

In this outline no attempt has been made to itemize the miscellaneous accessories needed. It is intended to cover the main items of equipment for large-scale operations, and some of the items may, therefore, be omitted in the case of smaller plants.

Sources of Income

The only sources of revenue considered herein are those products that are in general demand and that are not likely to be lowered excessively in price even by extensive production. They are products which experience in the established shale-oil industry of Scotland has shown may yield a profit. There is no intention of saying that other products may not, in isolated cases, yield profits, but it is not as yet safe to figure on them as general products of the industry.

The known general sources of income are: crude oil.

gasoline, kerosene, gas oils, lubricants,¹ wax, ammonium sulphate possibly, and shale gas² and producer gas from spent shale when ammonium sulphate is made.

The total income from these sources must be sufficient to cover the cost of production, marketing and general expenses, and yield a profit on the capital invested. Refining losses larger than those from crude petroleum must be allowed for. The marketing expense may include some contribution towards educating the public to the use of products in some respects different, but not necessarily inferior to those obtained from crude petroleum.

Capital Investment

In the following outline it is assumed that the company owns its shale land, does its own mining, and operates its own retorts, refinery, wax and ammonium sulphate plants. All manufacturing operations are carried on at the same place as the shale is mined, the products being sold to distributors and shipped in the company's own tank cars or other containers.

The three principal items under capital invested or first costs are: Land, buildings, machinery and equipment.

¹ Scotch experience, and investigations of the Bureau of Mines have indicated that it may not be possible to produce more than moderately viscous oils from shale.

² Reduces fuel cost.

Land and Buildings

This includes cost of land, legal expense, surveying, sampling and preliminary assays, water supply system, and roads and sewers.

The principal mine buildings required are a fan house, hoisting engine house, locomotive shed, machine shop, tool house, and storage bins. Retorting buildings will include housing for crusher, housing for retort and condensers, and housing for ammonium sulphate plant. In addition to mining and retorting buildings, there will be required several miscellaneous refinery buildings, a warehouse, laboratory, garage, office and camp for labor.

Mining Machinery

Mining machinery needed will include hoists, hoisting engines, fans, locomotives and cars, pumps and pipe lines, drills, conveyors and rails.

Retorting Equipment

Retorting machinery covers such items as conveyors, crushers, retorts and condensers, scrubbers, pumps and pipe lines, gas producer (if desired), storage tanks, ammonia fixation plant, and producer gas plant.

Refining Equipment

The principal items required under refining machinery are stills (primary and re-run), condensers, heat exchangers, agitators, filters, compounding machinery, wax plant, candle factory (if desired), chemical recovery plant, cooling towers or spraying pond, pumps and pipe lines, oil storage tanks and fire protection system.

Power Plant and Miscellaneous

For the power plant there will be needed boilers, engines, dynamos, measuring and recording instruments, motors, pumps and compressors.

In addition to the foregoing, there will be required laboratory equipment, garage equipment, warehouse equipment, loading and delivery equipment, office equipment, and camp equipment.

Operating Costs

The cost of producing shale-oil products would be the sum of the costs of each process, as mining, crushing, retorting, fixing ammonium sulphate, and refining. The cost of each process would consist of the following main items: Labor, supplies, supervisonal salaries of foreman, superintendents, etc.; clerical salaries connected with the works; fixed plant charges, as taxes, insurance, interest and depreciation; variable plant charges, as power, water, camp, etc.

In addition, there would be added to mining costs, (1) depletion or exhaustion of the property per ton of shale mined, and (2) development or opening up new property, the total cost of which would probably be a deferred expense to be amortized against the mined shale.

Selling and General Expenses

The main items of selling expense would be: Salaries and commissions, advertising, traveling expense, office supplies and expense, shipping department expense, repairs and maintenance of delivery equipment, and depreciation of delivery equipment.

The main items of general or administrative expense would be: Salaries of general officers, general office expenses, and deferred charges, usually consisting of organization expenses.

It must be remembered that the foregoing list is only general in its application and not intended to fit any particular shale-oil business. If different methods of operation were used than those indicated, the items of equipment and expense would of course be changed.

Industrial Notes

Merger plans are being perfected by the Alpha Portland Cement Co., Easton, Pa., and the Cement Securities Co., Denver, Col., with the formation of a new company under the name of the Alpha Cement Co., capitalized at \$30,000,000. The different plants of the combined company will be extended and improved.

* * *

Atlas Powder Co.'s gross sales for 1920 amounted to \$24,393,569, an increase of \$5,286,227 over 1919. Net operating income represents a return of 34.95% per share of common which after reduction for inventory adjustment amounts to 16.22%. President W. J. Webster, in his annual report, stated the company continues to operate research, development and experimental laboratories, and during the year succeeded in developing and marketing improved explosives and investigated many affiliated lines, with a view of developing advantageous fields for the use of its organization.

* * *

The United States Bureau of Mines at the request of Hon. John M. Parker, Governor of Louisiana, is preparing to conduct an investigation regarding methods for the conversation of natural gas in that state. The investigation will be made by R. A. Cattell, petroleum engineer, under the general direction of H. W. Bell, engineer in charge of the field office of the Bureau of Mines at Dallas, Texas. The work will begin probably in the extensive Monroe field in northern Louisiana, but will be extended later to embrace all fields in the state. The expense of the investigation will be borne by the State of Louisiana. It is expected that the work will cover a period of several months.

* * *

The French Government has contracted with the Badische Anilin und Sodafabrik for the use in France of the Haber patents for nitrogen fixation, which patents will be transferred to a new company, the Compagnie Nationale de l'Azote, which is being formed by the Banque de Paris et des Pays-Bas. The capital stock will be 12,500,000 francs, of which 2,000,000 francs preferred stock has a voting power twenty times that of the common stock and is, therefore, in control. Among the institutions interested are Banque Francaise pour Commerce et l'Industrie, Banque de l'Union Parisienne, Mines de Bethune, Compagnie Nationale des Matieres Colorantes and Etablissement Kuhlmann.

* * *

The early completion of the government plants for the extraction of helium from natural gas, at a cost aggregating \$7,000,000 and located near Fort Worth, Texas, and Petrolia, Kan., demands now an appropriation for this operation for which \$1,200,000 is asked of Congress divided equally between the Army and Navy appropriation bills. The estimated annual cost of operations at the Fort Worth plants is \$885,000 and from \$270,000 to \$300,000 at Petrolia. Fort Worth plant No. 1 uses the Linde system and is a duplicate on a larger scale of the original experimental plant. Plant No. 2 uses the Claude system. Plant No. 3 (at Petrolia) uses the Jefferies-Norton system. The government built a pipe line from Petrolia to Fort Worth to transport the natural gas which after extraction of helium is consumed in Fort Worth and adjacent territory. The importance of helium as a non-inflammable, incombustible gas of a buoyancy approaching that of hydrogen for use in observation balloons warrants the completion of the government plans by the operation of these plants.

Cottrell Electrical Precipitator Installation at Plant of the American Acid Co., Medford, Mass.

By W. J. Kee

Superintendent, American Acid Co., and

F. H. Viels

Engineer of Construction, Research Corporation

THE installation of the Cottrell electrical precipitation processes at the American Acid Company's chemical plant at Medford, Mass., was built to clean the gases from a 50-ton O. V. sulphuric acid concentrator, Chemical Construction Co. type. The cleaning of these gases has a two-fold purpose, viz., (1) the abatement of a nuisance caused by emitting sulphuric acid fume or mist into the atmosphere of the community and (2) the recovery of sulphuric acid otherwise lost.

The gases treated are the combustion products which have been brought in contact counter-current with dilute sulphuric acid while it flows downward over quartz packing heated by such hot gases of combustion. These hot gases absorb water as mist or steam from the dilute acid. With this mist and steam there is a considerable quantity of dilute

electrode surface where they collect and run off in the form of a dilute sulphuric acid, the corrosive nature of which made it necessary to construct all parts of the apparatus which would come directly in contact with the untreated gas, of material not effected by sulphuric acid. Lead is the most satisfactory material for this purpose and has been used throughout on the installation.

The charged surfaces or electrodes in this installation consist of two sets, viz., collecting or positive electrodes and discharge or negative electrodes. The collecting electrodes consist of a number of eight-inch inside diameter lead pipes twelve feet long which are grounded. The discharge electrodes are made up of wire with a fluted lead covering which forms a sort of six pointed star in cross-section and has a diameter of approximately



Fig. 1. Cottrell Electrical Precipitator Showing Gases from Concentrator—Current Off

sulphuric acid in the form of small liquid particles, as well as sulphuric anhydride (SO_3).

The Cottrell electrical precipitator designed for this installation accomplishes the desired separation of acid particles and water mist from the air by collecting the particles together into larger particles and depositing them on the sides of the electrode system; any SO_3 present is at the same time converted to H_2SO_4 . This is done by bringing the gas through a high voltage unidirectional electrical field.* This electrical field maintained between two metallic surfaces charged to potentials of opposite polarity produces two effects tending toward a separation of the liquid particles from the air. First, the particles are ionized or given a definite individual charge which tends to make them exert a force on each other and on the adjacent charged surfaces. Second, an electrical wind is created which blows these particles toward one



Fig. 2. Cottrell Electrical Precipitator. Same View—Current On

three-eighths inch. One discharge electrode is placed coaxially through each of the collecting pipes. The distance or spacing between the negatively and positively charged electrodes is equal to the radius of the eight-inch diameter pipe less the radius of the three-eighths inch diameter wire at the center. These wires are insulated from the ground and carry a negative potential of from fifty thousand to sixty thousand volts measured by transformer ratio.

A continuous electrical discharge takes place from the negatively charged electrodes which appears as "corona" or "brush discharge." When viewed in the dark this "silent discharge" is visible in the form of small tufts of light along the projecting edges and at any prominent points of the electrode; it is also accompanied by a low hissing sound.

*Lefax 30, G 21.30.

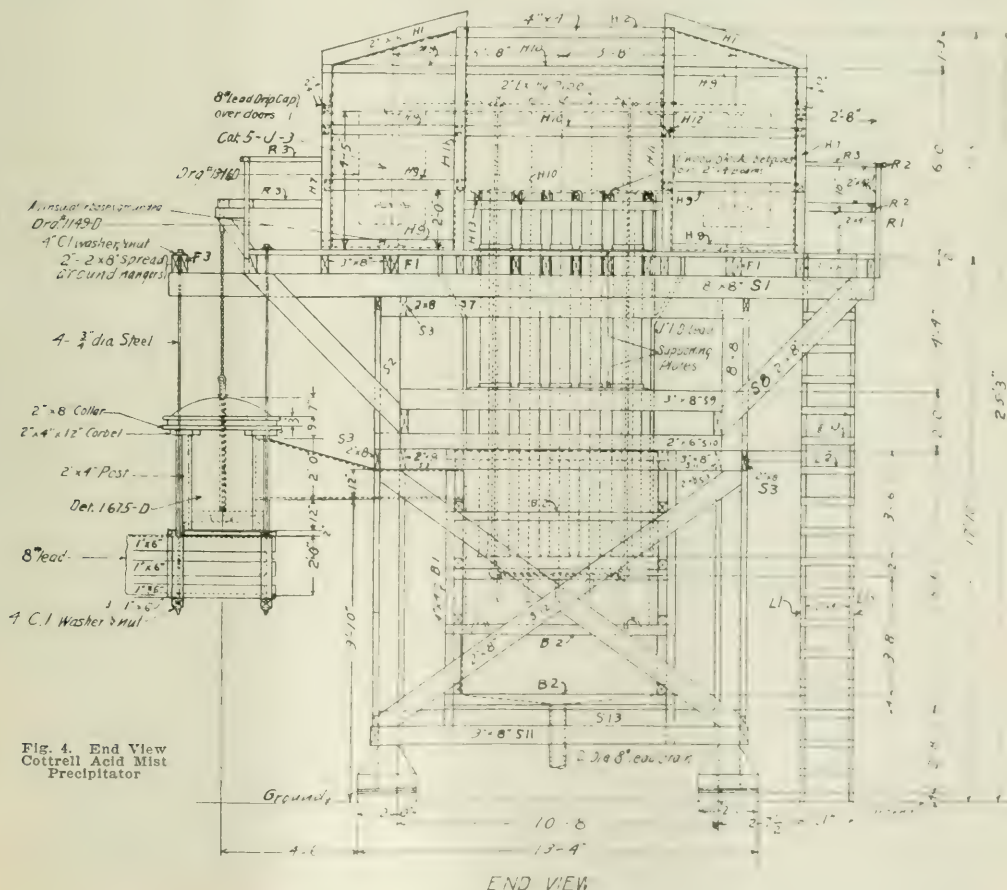
The discharge electrode system consists of iron wires, with fluted lead covering, suspended, one down the center of each of the collecting electrode pipes. These wires are supported at the top by lead-covered iron pipes and are held taut by a lead weight of approximately fifteen pounds at the bottom end. The lead covered bus-bar structure, supporting the discharge electrode above the heater pipes, is carried on four insulators placed just outside the top header-box opposite eleven-inch diameter holes in the lead side walls through which the supporting members pass.

The insulators supporting the discharge electrodes are of porcelain and are three feet high tapered from a ten-inch circular base to a four-inch circular head and have corrugated sides to increase the leakage surface. The insulators are protected from accumulations of acid mist and dust by a hood which consists of a metal cylinder two feet three inches in diameter by three feet nine inches deep closed at the top open at the bottom end being over the insulator. A light wooden housing is provided over the top and around the other three sides of these insulators to give further protection from the weather and conductive deposits.

Electrical Equipment

The electric power used in the precipitator is at a high potential and in order to maintain the electrodes at opposite polarity must be unidirectional instead of alternating, as most service is supplied. Power in this form is obtained from standard alternating current service delivered at a potential of two hundred twenty volts by transformation and rectification. Connections are made through a step-up transformer having a ratio suitable to give the desired potential of fifty thousand to sixty thousand volts at the outlet terminals. The transformer is provided with taps on its primary winding which enables the operator to change the ratio of transformation to obtain the desired potential on the secondary terminals.

The high voltage alternating power is transmitted to the mechanical rectifier or "reversing switch" which is driven in synchronism with the power supply by means of a three horse power synchronous motor. This synchronous switch or rectifier is so arranged that a contact is made over approximately ninety electrical degrees of the wave form twice during each cycle. By means of this arrangement the negative impulse of the wave is permitted to pass directly to the line. Then the



contact is broken and by the time the polarity in the transformer has been reversed the connection between the terminal and the line have also been reversed so that again the negative potential passes direct to the line. This gives, not a true direct current, but a unidirectional intermittent flow of current having one hundred and twenty impulses per second. However, the electrical field between the electrodes in the precipitator is maintained something near constant by the condenser capacity of the precipitator itself.

In order to obtain regulation between the voltages supplied by the various ratio taps of the transformer, a non-inductive series resistance is provided in the primary circuit. This resistance is divided into eight steps and so arranged that it can be controlled from the switchboard as to the amount which is inserted in the line.

The operation of the concentration plant being continuous the precipitator is operated twenty-four hours each day with only occasional shut-downs for oiling and minor repairs.

The power consumed by this equipment averages 100-150 kilowatt-hours per day. The performance of the precipitator is practically one hundred per cent. so far as the removal of the liquid particles actually suspended in the gases is concerned. The gas emitted from the top of the precipitator is, of course, cooled by its contact with the atmosphere and being already saturated, water particles are condensed out after these gases come in contact with cold air. Sometimes during cold weather this appears as a mist above the top of the precipitator. However, a close observation of the exit will estab-

lish the fact that the air leaving the top of the pipes is entirely clear and that the moisture condenses, after the air leaving the pipes has come in contact with the cooler atmosphere surrounding. This air, leaving the top of the treater, can readily be breathed without harmful effect and without detection of any very decided odor other than that produced by the gases which are the product of combustion used in heating the checker work in the concentrating tower itself.

Recovery

The precipitator recovers approximately 1500 lbs. of sulphuric acid (66° B.) per day which has a concentration averaging 22° Baumé. Since the installation of the precipitator, no sprays are used in the scrubber tower directly preceding the precipitator. The resulting drip acid recovered indirectly but as a result of the precipitator operation, amounts to about 9500 lbs. per day of equivalent 66° B. acid. The total recovery therefore averages 5.5 tons equivalent 66° B. acid per 24 hours.

Cost of Installation

The cost of the installation complete, including the precipitator and all the necessary special electrical equipment amounted to \$15,000 approximately. Construction work on this installation was started in September, 1920, and the precipitator was initially placed in operation during November, 1920.

A few months' operation has completely demonstrated that the precipitator has eliminated from a rather particular residential neighborhood a very troublesome nuisance.

Production Costs and Conditions in Chemical Manufacture

AT no time in the history of the American chemical industry has the scrutiny of production costs been keener than at the present time. Temporary conditions have been met by retrenchment in every department of the industry. Methods in management and processes employed in the period of war-time production when all chemical products were favored by seller's market must be cast aside to meet conditions that compel the closest study of production costs.

The reorganization thus necessitated by conditions in the domestic market is reinforced also by conditions confronting those who seek an outlet in export trade. Production costs are admitted generally to be higher here than in those countries whose competition the producer for export must meet. Advantages inherent in tonnage production and labor-saving appliances must be supplemented by scrutiny of details looking to the elimination of bad practices which though separately may be trifling in the aggregate are determinative in fulfilling commitments on a satisfactory basis of profit.

Production in a chemical plant may be influenced by a great variety of factors. Chief among these is the question of yield, which in itself depends on the close adherence to the prescribed conditions for the particular reaction to be carried out. These conditions usually take into account temperature, pressure, concentration, speed of reaction, various kinds of testing during the progress of a reaction, etc., all of which details must be closely followed to insure a successful operation.

The breaking down of some part of the mechanical equipment is not an infrequent occurrence in chemical works, due to high corrosive action and great wear and

tear on machinery by the materials used. This, however, is often due to faulty or improper design and the production superintendent is in many cases not to blame, because of this fact. We cannot lay too much stress here on this point, as chemical manufacturing is a procedure which requires careful study of the minutest details. The proper design and layout of machinery are most essential.

Variation in raw material sometimes causes trouble in production, but proper chemical examination of these materials before they are used should reduce this factor to a negligible quantity. However, considering that we have all sorts of labor to contend with and that for many positions the turnover is quite large, things sometimes will go wrong and it is for this reason that the superintendents and foremen must be very resourceful in overcoming difficulties, and must have somewhat of an instinctive capacity for scenting trouble and locating defects in order that production may be maintained on a satisfactory basis.

There is yet another important factor which we may mention, and that is the checking-up periodically among superintendents and foremen as well as many workmen, of the details of the processes used, as individual changes in procedure creep in unconsciously and gradually their effect becomes multiplied, until the process in use has deviated to a dangerous extent from the one originally prescribed. The writer has had occasion to experience just how much distortion processes will undergo during a period of time, due to the introduction of these apparently slight but multiplying individual changes.

The Fleischmann Company

THE compulsory elimination of the production and vending of whiskey from a business intimately dependent upon delicate biological and chemical control, not only compelled radical adaptation to changed conditions, but concentration to develop new uses for a by-product that had perforce become the main product.

The Fleischmann Co. dates from 1905 when it was organized to take over the business of a co-partnership established in 1868, and which introduced into the United States from Europe the manufacture of compressed yeast which is now distributed to about 35,000 commercial bakeries, hotels and institutions, and to about 175,000 grocers through the medium of over 900 agencies in the United States, Canada, Cuba and Porto Rico.

In addition to yeast, malt extract is made and, as by-products of yeast, vinegar, industrial alcohol and cattle feed.

Research

The company maintains extensive experimental and research laboratories for developing new and improved processes for the manufacture of its various products and for developing new uses for its compressed yeast and other products.

Within the last 3 years, through research and experimental work, new and valuable processes of yeast manufacture have been developed and new uses for yeast have been discovered; and by means of extensive advertising and methods of sales promotion yeast as a health food and as a medicinal agent in certain common disorders has been brought home to the public, resulting in enormous increases in the sale of this product.

Subsidiaries

The American Diamalt Co., located in Cincinnati, is the largest maker of malt extract in the United States, which is used by bakers as an ingredient of commercial bread. The Fleischmann Malting Co. supplies the malt. It maintains six malting and elevator plants in Chicago, Minneapolis, and Red Wing, Minn.; Davenport, Iowa; Louisville, Ky., and Buffalo, N. Y., with a malting capacity of 5,000,000 bu. per annum, a large part of which is used by the Fleischmann Co.

The Fleischmann Transportation Co. operates 175 vinegar tank-cars and conducts a trucking business in the cities where the Fleischmann plants are located, which embrace two in Peekskill, N. Y.; one at Berthier-ville, Ont.; two at Baltimore, one at Langdon, D. C.; four at Chicago, one at Sumner, Wash., and one at San Francisco.

Earnings and Capitalization

On account of the Federal war-time prohibition enactments in 1917 and later the Constitutional amendment prohibiting the sale of alcoholic liquors for beverage purposes, the company was forced to liquidate its large stocks of alcoholic liquors, close up its beverage distributing branches and re-equip its factory properties for the manufacture solely of compressed yeast and its other products, all of which was done from 1917 to 1919, inclusive, during which years, in spite of the radical changes which had to be made, the business of the manufacture and distribution of compressed yeast was carried on without interruption, and this was done without any substantial increase in the price of yeast to the trade.

Earnings for Calendar Years

Sales		Net Profits		Sales		Net Profits	
1910.....	\$15,729,978	\$1,189,585	1916...	\$25,762,057	\$2,075,293		
1911.....	16,156,471	1,176,799	1917...	27,520,606	1,765,989		
1912.....	17,771,970	1,504,887	1918...	32,191,378	3,393,331		
1913.....	18,322,951	1,831,242	1919...	16,343,670	1,858,349		
1914.....	19,139,317	1,829,730	1919...	31,951,786	2,421,357		
1915.....	19,225,811	1,829,438	1920.....	16,343,670	1,538,349		

*Applicable to interest on notes and Federal taxes

Capitalization

	Authorized	Outstanding
Common stock (all owned by Fleischmann family).....	\$3,000,000	\$3,000,000
Preferred stock, 6% cumulative.....	3,000,000	3,000,000
8% 10-year notes, due Dec. 1, 1930.....	3,000,000	3,000,000

Administration

Throughout its history the Fleischmann Co. has been continuously conducted and controlled by members of the family of Charles Fleischmann, who with Maximilian Fleischmann and James W. Gaff, established the business in 1868.

The directors comprise Julius Fleischmann, Max C. Fleischmann, Henry J. Kaltenbach, Paul W. Fleischmann, Alfred Knight, Thomas L. Smith, Dr. Alois Zeckendorf, Julius F. Behrend, Hugo A. Oswald.

The officers are: Julius Fleischmann, president; Max C. Fleischmann, first vice-president; Henry J. Kaltenbach, Paul W. Fleischmann, Alfred Knight, Thomas L. Smith, Dr. Alois Zeckendorf, Joseph Wilshire, Robert L. Corby, and Henry R. Newcomb, vice-presidents; Julius F. Behrend, treasurer; Hugo A. Oswald, secretary; Charles Kayser and A. B. McNamara, assistant secretaries.

Industrial Notes

The General Chemical Co. is erecting a four-unit contact sulphuric acid plant at its Bay Point, California, works.

* * *

The Bureau of Development of the Department of Agriculture will establish at Fitzgerald, Ga., a semi-commercial plant for the manufacture of syrup from sweet potatoes by the process worked out by Dr. H. C. Gore of the Bureau of Chemistry, in connection with a sweet potato curing and storage establishment at that place.

* * *

The extensive acquisition of allied lines of business by Lever Bros., Ltd., of Great Britain, has encouraged criticism that the expansion has outdistanced trade requirements. The present authorized capital stock is £130,000,000 of which £42,000,000 have been issued. Report is to the effect that arrangements are under way for the creation of £10,000,000 Lever Bros. debenture bonds of which public offering soon will be made. Apparently conditions are considered unpropitious for selling more capital stock, hence the decision to create a bonded debt.

* * *

Lewis W. Leach, manager, Colorado Carbon Company, Inc., De Beque, Colo., has addressed Governor Parker of Louisiana and John H. Overton, Alexandria, La., who has drafted a clause to be presented to the Louisiana Constitutional Convention in March empowering the General Assembly to stop the carbon manufacturers from operating in that state for conservation reasons, offering practical information as to damages he sees the operators in Louisiana will do the state in manufacturing carbon black from natural gas.

Manufacture of Ethyl Alcohol from Wood Waste

A Chemical Engineering Study of Sawdust Economics

By E. C. Sherrard

Chemist in Forest Products, Forest Products Laboratory, U. S. Forest Service, Madison, Wis.

THE general agitation in regard to a more efficient utilization of forest resources and forest products directs attention to the large quantities of sawmill waste that are daily disposed of at a loss or at best with a return barely sufficient to defray the cost of such a disposal. By the term "mill-waste" is meant the waste wood in the form of sawdust, slabs and edgings from the mill operation over and above the fuel requirements of the plant. The utilization of this waste presents problems that differ widely at different mills depending upon the location of the mill, the kind of wood cut and the quantity and kind of mill waste available.

For the utilization of large quantities of this material only a few methods have been developed. It is needless to point out that some favorably located mills whose waste consists largely of sawdust and shavings can dispose of it directly. Such favorable locations, however, are few and the transportation of waste consisting largely of sawdust is not economical because of its extreme bulkiness.

In order that the value of this waste product be increased by conversion into a form that will warrant transportation from isolated localities to market centres a chemical treatment is necessary. Two processes have been developed with this purpose in view depending upon the conversion of the waste wood into (1) ethyl alcohol or (2) pulp and paper. Of these two processes the conversion of the waste to pulp is eliminated in all cases in which the waste is composed largely of sawdust since it has been found that fibre obtained from sawdust is too short to make a high grade paper.

In other cases when the waste consists largely of slabs and edgings from barked logs the process is worthy of consideration providing that the mill can see its way clear to make the initial investment. The cost of installation of a plant of this type is estimated at \$20,000 per ton of pulp or \$40,000 per ton of unbleached paper. The initial investment is practically the same for plants using the sulphite, sulphate or soda process.

Ethyl Alcohol from Wood

Processes used for the conversion of wood into fermentable sugars may be grouped into two general classes, viz., (1) those employing a concentrated acid and (2) those using a dilute acid under pressure.

The first method depends upon a complete solution of the cellulose in a highly concentrated acid. The resulting products are then hydrolyzed to sugars by boiling with a large volume of water. By this process yields of sugar corresponding to fifty per cent. of the dry weight of the wood are obtainable but the disadvantages connected with the process more than offset the advantage of a high sugar production. The disadvantages are (1) the lack of a satisfactory method for the recovery of the acid used, a necessary procedure in view of the large quantity of acid required, and (2) the difficulty of constructing apparatus capable of withstanding the corrosive action of the hydrolyzing agent.

The Process

The second process is commercially feasible and has been used successfully in this country by two plants

for the last few years. It is, however, limited at present to those mills cutting soft woods since experiments have shown that the yields are about one-third greater from coniferous wood than from the broad-leaved variety.

This process consists of digesting sawdust or a mixture of sawdust and shredded mill-waste with dilute sulphuric acid for 15-20 minutes at a steam pressure of 115-120 pounds. This operation is carried out in a rotating digester lined with acid-resisting brick and results in a conversion of 20-25 per cent. of the dry weight of the wood into sugars of which about 75 per cent. are fermentable.

The sugars thus produced are then removed from the digested material by extracting with water in a diffusion battery similar to those used in the beet sugar industry. The sulphuric acid is eliminated from the sugar solution by treating it with lime or calcium carbonate and allowing the sludge to settle. The settling requires fifteen to twenty hours. The clear solution is then drained off, cooled to the proper temperature and fermented in much the same way as is cane sugar molasses. The alcohol produced is removed by distillation and rectified in a manner similar to that employed in the manufacture of industrial alcohol from grain, molasses or other materials.

Plant Requirements

The essential parts of a plant necessary to produce ethyl alcohol from wood, considered in order of their use, are the following:

- | | |
|---|---|
| 1. Dust house for the storage of an adequate supply of sawdust. | 6. Diffusion battery. |
| 2. Hogs, shredders and screens. | 7. Neutralizing and settling tanks. |
| 3. Sawdust storage above digesters. | 8. Coolers. |
| 4. Acid and lime storage and mixing house. | 9. Fermenting tubs and yeast equipment. |
| 5. Digesters. | 10. Beer still. |
| | 11. Rectifying still. |
| | 12. Bonded warehouse. |
| | 13. Boilers and engines. |
| | 14. Laboratory and office. |

Sawdust Storage

Adequate sawdust storage will vary with the location and continuity of operation, the sawmill and character of the logging operation. The operation of the plant and distillery must be continuous. The storage must be sufficient to permit compliance with the necessary regulations of the Internal Revenue Department regarding the operation of distilleries. The latter are surveyed as to their output and must produce daily the amount required in this survey or be penalized with the tax on such a quantity of alcohol as is necessary to make up the survey.

In general, therefore, the alcohol plant should have at least a 15 days' supply of wood on hand and where logging operations are such as to require frequent shut-downs, the alcohol plant should have sufficient material in storage to tide over these periods. The hogged and shredded waste can be stored in any type of building that offers sufficient protection from the rain. Belt conveyors can be used to handle the material and a long covered shed with an inclined bottom terminating in a trough, similar to those used for the storage of sugar beets would answer the purpose.

Disintegrating Equipment

This consists of hogs or chippers and shredders and screens. Although a chip one-half inch with the grain will be thoroughly penetrated with the acid it is desirable to have chips or fragments 3/16 to 1/4 inch since the leaching of the sugar from the smaller particles is much more complete and requires less time. After screening and reshredding the fine material is conveyed by belt to the loading bin over the digester floor.

Sawdust Storage Above Digesters

The loading bins should be of sufficient size to act as an intermediate storage for the material as it passes from the screen on its way to the digesters. Each bin should have the capacity of four or five digesters and should be placed over the digester and tapered down so that the material can flow directly into the digester in the same manner as in a chemical pulp plant.

Acid and Lime Storage

The sulphuric acid is best stored in the condition in which it is received, i.e., in the concentrated form. The acid in this form can be stored in steel tanks and pumped to a lead-lined tank above the digester for dilution to the proper strength. It is then allowed to flow into the digesters along with the sawdust where the two are intimately mixed by rotating the digester.

The lime should be stored in a dry building not far distant from the neutralizing tank. The lime is first converted into a milk of lime by mixing in a small tank equipped with a stirrer. The milk of lime is then pumped to the neutralizing tub as needed.

Digesters

The digesters may be either spherical or cylindrical with dished ends. In the latter case they should have a diameter double the length of the cylindrical section so as to fill as completely as possible. A number of satisfactory acid-proof linings are obtainable at present and but little trouble is experienced from this source. The size of the digesters will be governed by the daily capacity of the plant, the heating period and the time of the complete cycle per digester. If the heating period is fifteen minutes out of a total of one hour for each cook four digesters, or multiples of four, should be used, whereas if the heating period is twenty minutes out of a total of one hour only three or multiples of three should be used.

In this way the steam load on the boilers will be as uniform as possible and the boiler capacity will be dictated largely by this load, since the rest of the load for power and distillation purposes will be generally constant. In addition, the hogging, shredding, and digester capacity of the plant should be such that it will give sufficient digested sawdust in 18 or 20 hours to run the rest of the plant 24 hours, thereby giving time for repairs and break-downs.

The cooked sawdust can be discharged merely by rotating the digester and falls into a bin which receives the cooked material from all the digesters and from which it goes by a mechanical conveyor to the different cells of the diffusion battery.

Diffusion Battery

Closed cells similar to those used for the extraction of sugar beets or dyewood chips can be used. These should be lined so as to be acid-resistant like the digesters and the top and bottom should be arranged so that charging and discharging can be accomplished readily. Cells of this type can be obtained in which the extracted

material will empty itself after a release of the bottom of the cell. The temperature of the extracting water should be from 75-90° C. since this will give not only a greater solubility than colder water but will also sterilize it and will keep the juice sterile while it is settling after neutralization.

The size of the cells and the number of cells in the battery and the amount of water per cell will be governed by the size of the plant and the size of the material that is cooked, since, sawdust for instance, will extract more readily than larger material. From data obtained in commercial size units it may be said that at least a five-cell draw, that is, passing the extracting medium five cells in rotation, is necessary and that a six or seven-cell draw is more desirable.

Since the sugars are readily soluble, only a short extraction period is necessary, that is, of from 50 to 75 minutes. This time, however, will be governed in part by the length of time that it takes the water to drain through each cell, which in turn depends on the size of the cell. The cells should not be too large, or the extracting water will not pass through the material easily, and the amount of water used should be such that the resulting extract is of the proper concentration for fermentation, which is from 11-12° Brix. The Brix will go up another degree on neutralization.

Just as in the case of laboratory extraction, or washing or precipitation, a large number of extractions or washings with small amounts of liquid will give a better extraction or more thorough washing and a more concentrated extract, than fewer extractions with larger amounts of extracting water for each extraction.

Neutralization and Settling Coolers

After extraction the acid extract is nearly neutralized with solid or milk lime or a high grade limestone (a magnesia stone is undesirable) and is then allowed to stand so as to settle out the sludge of calcium sulphate. This usually requires from fifteen to eighteen hours so that adequate tank capacity is required here.

The clear juice is then drawn off and passed through coolers to reduce its temperature to about 27° C., from which it goes into the fermenting tanks. The coolers should be of copper and their size will depend upon the temperature of the water supply available.

Fermentation, Distillation, etc.

A 96-hour fermentation period is permitted so that a four-day fermenter capacity is required. The size of the individual fermenter will be dictated largely by local conditions, such as mean temperature. The other equipment is the standard distillery equipment in use at present in grain or molasses distilleries.

Power Requirements

The steam load of the plant will be distributed about as follows:

	Per Cent.
Pumps	20
Boiler, fire, general water supply, beer, alcohol.	
Digesters	30
Hogs and shredders	20
General power for driving conveyors, digesters, etc.	15
Distillation and rectification	15*

A large supply of pure cool water is necessary. It should be pure for boiler and extraction use and should be cool for use in cooling and condensing. The dis-

*Including all exhaust steam not used for heating boiler feed and extraction water. If large quantities of exhaust are not available, distillation and rectification may require as high as 40 per cent. of the total load.

posal of the beer-still slops requires attention because of the large amount of pentose carbohydrate, and also of dead yeast which is highly nitrogenous and which would lead to rapid putrefaction.

Recent investigations indicate that the yeast remaining after the fermentation is completed can be digested under slight pressure with the production of a good yeast nutrient that can be used in subsequent fermentations. Such a procedure materially cuts the costs of fermentation since it eliminates the malt sprouts formerly used for this purpose.

Yields

While it is unfortunately true that several early failures occurred in plants using this process these failures were due to (1) difficulties encountered during the general development of the process because of the lack of experience in the commercial application of such a process; (2) promotional difficulties; (3) lack of technical experts in this field who have the necessary chemical, engineering and bacteriological skill to develop the operation; (4) difficulties have also been encountered by the erection of a plant at a point when insufficient quantities of wood were available, a condition which naturally interferes with the continuous operation of such a plant.

The fact that two plants have operated successfully in this country for the past few years indicates that the process is commercially feasible. Investigations at this laboratory indicate that after allowing the necessary manufacturing losses, a yield of 20 gallons of 95 per cent. alcohol per ton of dry wood is obtainable from the coniferous wood. The yields from the different species of both hardwood and soft wood are as follows:

Alcohol Yields from Hard Woods.

Species of wood	Total reducing sugar in dry cent of dry original wood	Per cent. of total reducing sugars fermentable	Per cent. of total reducing sugars unfermentable	Alcohol yields		
				In per cent. of original wood	In gallons of absolute per dry ton	In gallons of 190 Proof per dry ton allowing 5% distillation loss
Birch	20.53	46.29	53.71	4.20	12.97	12.95
Hard maple	18.93	34.04	65.96	3.03	9.16	9.14
Silver maple	20.74	47.22	52.78	4.66	14.10	14.07
Beech	21.24	22.22	77.78	1.99	6.03	6.02
White oak	17.30	50.48	49.52	4.10	12.40	12.38
Red oak	18.38	30.40	69.59	2.67	8.09	8.07
Sycamore	18.30	38.86	61.14	3.20	9.69	9.67
Slippery elm	16.60	26.79	73.21	1.38	5.99	5.98
Red gum	20.42	38.81	61.19	3.65	11.06	11.03
Cottonwood	18.19	32.86	67.14	2.39	7.23	7.21

Alcohol Yields from Soft Woods.

Idaho white pine	21.00	74.49	25.51	7.76	23.48	23.43
Red spruce	20.48	74.16	25.84	7.56	22.88	22.84
Douglas fir Mont.	21.10	67.42 ^a	32.58 ^a	6.82	20.64	20.59
White pine	20.02	75.67	24.33	7.43	22.48	22.46
Longleaf pine	23.06	73.32	26.68	8.28	25.05	24.90
Longleaf pine	23.25	72.49	27.51	8.33	25.20	25.16
Lodgepole pine	21.93	67.37	32.63	7.20	21.79	21.75
Norway pine extra chips	25.62	66.88	33.12	7.74	23.42	23.38
Red spruce	22.06	72.67	27.33	7.95	24.06	24.01
West larch ^b	29.72	37.89	62.11	4.97	15.05	15.03
West larch ^b	30.52	57.88	42.12	8.68	26.26	26.21
West larch ^b	26.21	54.69	45.31	6.93	20.97	20.93
West hemlock	21.15	77.63	22.37	7.62	23.05	23.01
Sugar pine	18.03	72.55	27.45	6.27	18.96	19.93
Sugar pine	20.23	66.49	33.51	7.11	21.51	21.47
Douglas fir Wash.	21.13	75.16	24.84	7.93	23.99	23.95
White spruce	23.61	71.44	28.56	8.53	25.82	25.78

^a 1.8% acid—10 minutes cook.
^b 2.5% acid—20 minutes cook.

^c 2.5% acid—40 minutes cook.

Costs

Assuming a yield of 20 gallons of alcohol per ton of dry wood and a location where the supply of waste is uniform and constant for a period of twenty years or more and where there is a good supply of water and a fairly close source of sulphuric acid and lime, the estimated cost of 190 proof alcohol from wood in a properly designed and constructed plant of 3600 gallons daily capacity is shown in the accompanying table.

This estimate is based upon a plant using 225 cords of comminuted wood waste (180 tons of dry wood) per day, the assumption being made that a cord contains 1600 pounds of dry wood. The value of the wood is placed at 50 cents per cord for the wood used for the production of alcohol and for the wood used for the generation of the necessary power. No account is taken of the fuel value of the digested residue which in all cases is pressed and returned to the boiler house for fuel. The wood used for the preparation of alcohol should as noted before consist of sawdust and shredded slabs and edgings but should not contain over 10 per cent. bark since the yield of sugar from bark is extremely low. A large quantity of bark would necessitate the handling of a large volume of inert material at considerable expense without a reasonable return in addition to increasing the tannin content of the liquors, a condition which should be avoided.

A good supply of water is absolutely essential to the operation of an alcohol plant. A 225 cord plant requires about 100,000 gallons of water per day in addition to that required for the generation of steam. It is also desirable that the water be fairly cool since in some cases it is convenient if not necessary for controlling the temperature of the fermenting liquor.

Cost Data on the Manufacture of Ethyl Alcohol from Wood.

Item	Per year	Per day	Per gal.
Interest on investment \$250,000 at 6%.....	\$15,000.00	\$50.00	\$0.014
Depreciation \$250,000 at 10%.....	25,000.00	83.33	0.023
Taxes and insurance \$250,000 at 4%.....	10,000.00	33.33	0.009
Raw material:			
Wood at 50c. per cord.....	33,750.00	112.50	0.031
Sulphuric acid 60° Be. at \$17 per ton: 192 × 2% = 7.68% × 17.....	25,200.00	84.00	0.023
Lime 2.22 ton at \$15 per ton.....	10,000.00	33.30	0.009
Fermentation materials.....	12,310.00	41.03	0.011
Molasses: 45,000 gals. × 9c. = \$4,050.00			
Malt sprouts: 95,000 lbs. × 4c. = 3,800.00			
Ammonium sulphate: 52,500 lbs. × 8.4c. = 4,460.00			
Fuel for 800 B.H.P.: 100 cords 150 ton wood 40% moisture, 50c. cord.....	15,000.00	50.00	0.014
Labor: 302 man. hrs. per day at 50c. = \$151.60 44 man. hrs. per day at 92.5c. = 68.00	219.00		
Salaries.....	35,000.00	116.66	0.032
President.....	\$10,000.00		
Manager.....	7,000.00		
Chemist.....	7,000.00		
Sales manager.....	5,000.00		
Assistant chemist.....	3,000.00		
Clerks.....	3,000.00		
	35,000.00		
Repairs and Materials.....	22,500.00	75.00	0.021
Mechanical supplies.....	\$15,000.00		
Repairs.....	3,500.00		
General expense.....	4,000.00		
	\$22,500.00		
		898.15	0.247*

*When wood having a high volatile oil content is used the cost can be considerably reduced by recovering the volatile oil by condensing the blow-off from the digester.

Co-relative Cost Conditions

The operating time of the alcohol plant is, of course, dependent upon the sawmill operation. The above cost estimate is based upon a 24-hour day of three eight-hour shifts for all of the plant except the digester floor, neutralizers and lime and acid house using four digesters. The cooking of 225 cords can be completed in eighteen hours in two shifts of nine hours each.

An alcohol plant to be successful should have a minimum daily production of 1500 gallons of 95-per cent. alcohol. This would require 75 tons of dry wood or its equivalent in air dry or green condition and comparatively free from bark. A smaller plant than this would increase the distillation and rectification costs to a questionable figure because continuous operation would no longer be possible in a standard type of apparatus. Such a plant would cost from \$200,000 to \$250,000 under normal conditions.

Price Comparisons and Eventualities

At the present writing (December, 1920) denatured alcohol is quoted at \$0.80 to \$0.87 per gallon in the current monthly market reports. It is to be expected that the price will decline eventually to a point somewhat higher than prewar quotations of 30 to 40 cents per gallon due to a somewhat greater use. The price also may be influenced by a drop in the price of grain to a point at which its conversion into industrial alcohol would be profitable.

Under normal conditions most sawmills, particularly the large ones, produce waste in excess of their own

power requirements. In large mills equipped with efficient power plants this excess will be from 50 to 65 per cent. of the total quantity produced. The disposal of this waste by means of a burner is, therefore, almost invariably necessary. The cost of burning this varies widely with the size and efficiency of the mill but from figures available this expense ranges from 50-56 cents per cord. All waste, therefore, that could be converted into alcohol would yield a return of 50 cents per cord as raw material in addition to the profit on the alcohol produced. At the same time the cost of disposal would be eliminated.

Essentials

The successful operation of this process depends, therefore, upon the proper design, equipment and management of the plant. Large volumes of low-grade materials must be handled quickly and efficiently under unusual technical conditions. The perfection of the necessary acid-resisting pieces of apparatus, along with the experience of the plants that have been built and successfully operated, justifies a serious consideration of this process by mills having a large quantity of waste, the mere removal of which is an expense.

Personal Items

B. L. Meredith has been transferred from the Wilmington, Del., plant of the du Pont Company to its plant in Iquique, Chili.

* * *

Charles Glass, formerly with Butterworth-Judson Corp. and for the past two years manager of John C. Wiarda & Co., Brooklyn, N. Y., is now a partner of the Wilson Chemical Co., 108 Fulton St., New York, dealers in heavy chemicals and intermediates.

* * *

Bradford Webster, president, Dye Exchange Corporation, 141 Broadway, New York, will resume the practice of patent law in association with E. W. Bradford and F. W. Dahn, with offices in New York, Louisville, Ky., and Washington, but will retain his connection with the Dye Exchange Corp.

* * *

H. L. Lentz, formerly of the Pittsburgh station of the U. S. Bureau of Mines, is now chief chemist of the Robinson Milling Co., Salina, Kan.

* * *

Hiller Zobel, chemist, Pacific Coast Borax Co., has been transferred from research work at Death Valley, Cal., to the company's plant at Bayonne, N. J.

* * *

J. H. Roop, formerly with the Noblesville Milling Co., Noblesville, Ind., has been appointed chief chemist for American Stores Co., Philadelphia, Pa. American Stores Co. operates over 1,150 stores in Pennsylvania, New Jersey, Delaware and Maryland, together with three modern bakeries.

* * *

Paul Nobbe, formerly vice-president of the American Aniline Products, Inc., is now associated with the Commonwealth Color and Chemical Co., Brooklyn, N. Y., as vice-president and sales manager of the dyestuff department.

* * *

S. H. Chaplin, formerly at the Long Island City, N. Y., plant of the Loose-Wiles Biscuit Co., is now chemist for the Cape Cod Preserving Co., Onset, Mass.

H. L. Moyler has resigned his position as assistant superintendent of acid plants, Naval Proving Grounds, Indian Head, Md., to become general supervisor of acid production, Monsanto Chemical Works, Plant B, East St. Louis, Ill.

* * *

Louis S. Potsdamer, chemical engineer and in charge of ground barytes sales for the Chemical Pigments Corp., Philadelphia, Pa., has been appointed trustee in bankruptcy for the Resorcin Chemical Co. of Phoenixville, Pa.

* * *

Col. G. A. Burrell, 62 Cedar St., New York, who is in charge of oil refining construction for the France-Canada Shipping Corp., has returned from a three-months' business trip in Europe.

* * *

Dr. H. C. Gore of the Bureau of Chemistry, Department of Agriculture, has worked out a process for the manufacture of syrup from sweet potatoes. The syrup is rich in sugar, of a fine brown color, highly palatable and suitable for baking, candy-making and table purposes, and in the opinion of many equal to first-class cane syrup.

* * *

W. F. Harrington and Hunter Grubb of the E. I. du Pont de Nemours & Co., Wilmington, Del., have been appointed respectively director of the dyestuffs and of the paint and chemicals manufacturing departments which have been organized to replace the miscellaneous manufacturing department now discontinued in the production division of the organization.

* * *

Otto Kress, for the past four years in charge of the pulp and paper work of the Forest Products Laboratory of the U. S. Forest Service, has joined the staff of the Consolidated Water Power and Paper Company, Wisconsin Rapids, Wisconsin. This company operates four mills having a combined capacity in excess of 200 tons daily of newsprint, mitscherlich, ground wood and sulphite pulp. He will be engaged with technical problems in connection with the control and development of pulp and paper products.

Industrial Notes

Colgate & Co., Jersey City, N. J., will establish a soap plant at Louisville, Ky.

* * *

The International Agricultural Corporation will electrify its fertilizer works at Wales, Tenn., at a cost of about \$300,000.

* * *

The Scientific Apparatus Co., 162 West Thirty-fourth Street, New York, has increased its capital from \$25,000 to \$200,000.

* * *

Grass Fibre Pulp & Paper Corp., Leesburg, Fla., will erect a 50-80 tons daily plant to make paper pulp from Florida "saw" grass.

* * *

W. L. Savell, G. G. Frost and A. Killian, of Niagara Falls, N. Y., have incorporated as Savell & Frost, capital \$150,000, to engage in chemical research.

* * *

The Newport Co., Inc., Carrollville, Wis., has transferred its New York office at 120 Broadway to its distributing plant at Passaic, N. J., where also C. W. Turner, president, formerly at Milwaukee, Wis., will be located.

* * *

The National Liquid Recording Corporation, New York, has been incorporated, with a capital of \$125,000, by M. B. Cary, H. S. Barnes and F. J. McEwen, 115 Broadway, to manufacture measuring devices and recording equipment.

* * *

Hatcher Carbon Co., capital \$500,000, has been incorporated by H. G. Evans, Montgomery, Ala., L. S. Horner, Clarksburg, W. Va., and C. P. Hatcher, Columbia, Tenn., to manufacture carbon black and extract gasoline from natural gas in the Monroe, La., field.

* * *

Amendments to the internal revenue regulations affecting Hawaii will permit the utilization of cane molasses for alcohol production to the degree that within two years the territory of Hawaii will produce enough motor fuel for its own needs, including the requirements of the army and navy forces there, should their bases of supply be cut off.

* * *

G. J. Esselen, Jr., secretary of the recently organized cellulose section of the American Chemical Society, requests that members of the society contemplating presenting papers before this section on the occasion of the April 26th meeting of the society at Rochester, N. Y., should send titles and abstracts of their papers to him, care Arthur D. Little, Inc., 30 Charles River Road, Cambridge, Mass.

* * *

The appeal of Adolph G. Hupfel, Jr., president A. Hupfel's Sons, formerly brewers of New York City, to the Ways and Means Committee at Washington, for a protective duty of 50 cents on imported canned mushrooms, directs attention to an aspect of brewery utilization exemplified by the Hupfel concern and the Frank Fehr Brewery Co., Louisville, Ky. A domestic production of 400,000 lbs. out of an annual consumption of 7,000,000 lbs. of mushrooms offers encouragement to the protection of an infant industry. Mr. Hupfel expects to produce 200,000 lbs. this year in the former New York City brewery.

T. N. Dissoway, 412 East 7th Street, with G. G. Dallan and E. J. Fenning, Brooklyn, N. Y., have incorporated the Dissoway Chemical Co., with a capital of \$50,000.

* * *

The recently completed cottonseed oil plant of the American Cotton Oil Co., at Memphis, Tenn., is the largest in the United States. Twenty-four 15-box presses provide a daily crushing capacity of 350 tons of seed.

* * *

The Adamson Mfg. Company, East Palestine, Ohio, will engage in the manufacture of all kinds of storage, pneumatic and pressure tanks, welded pipe, battery casings, evaporators, condensers, and a large line of arc-welded products adaptable to the chemical industry.

* * *

During the fiscal year ended June 30, 1919, Federal revenue from alcoholic beverages amounted to \$483,000,000. During the succeeding fiscal year this source provided only \$140,000,000. On the other hand, the revenue from non-alcoholic beverages increased from \$7,000,000 in 1918-19 to \$57,000,000 in 1919-20.

* * *

From plans prepared by Gregg & Co., engineers, 24 Clinton St., Newark, N. J., the Lone Star Brewery (Anheuser-Busch) of San Antonio, Texas, has been transformed into a cotton mill for the utilization of local low-grade cotton. Present equipment comprises 10,000 spindles and 300 looms to consume 10-15 bales of cotton per day.

* * *

Anaconda Copper Mining Co. announces the early shipment of phosphate rock from its Soda Springs phosphate deposits in eastern Idaho. The Washoe, Mont., smelter alone will handle daily 1,000 tons of the phosphate ore, which will be treated with sulphuric acid, a by-product of the company's treatment of sulphide ores. The phosphate deposits extend over Idaho, Utah and Wyoming, from which some of the operating companies have been sending most of their products to the Orient, principally to Japan. The Anaconda deposits are sufficiently extensive to maintain shipments as at present contemplated for at least ten years.

* * *

Increased intimacy of contact of Swiss dye manufacturing interests with the American market appears in the acquirement of Aniline Dyes & Chemical, Inc., 134 Cedar Street, New York, by Society of Chemical Industry in Basle which will add the staff and facilities of the former organization to its sales agency, the Ciba Co., Inc., which will distribute the products of its Swiss plants together with those of the Ault & Wiborg plant in Cincinnati, recently acquired ostensibly by the Geigy Co., but in reality on behalf of the combined Swiss dye interests which embrace the Geigy Co., Ltd., the Sandoz Chemical Works, and the Society of Chemical Industry.

WANTED

Director of Research by an Industrial Research Laboratory near New York. Require a creative chemist who is not afraid to soil his hands by working in laboratory with assistant chemists, and who can inspire enthusiasm and loyalty in the staff. Good salary and opportunity to become associated with commercial developments on excellent basis.

Address R-25, care this journal.

CHEMICAL AGE

A CONSOLIDATION of THE CHEMICAL ENGINEER and CHEMICAL AGE

LLOYD LAMBORN, *Editor*

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American Chemical Industries and Foreign Trade

By John J. Raskob

Vice-President, E. I. du Pont de Nemours & Company; Member, Organization Committee, Foreign Trade Financing Corporation

NOT so long ago the chemical industries of the world were fighting each other on the battlefield. The war has stopped, but the chemical fight is being continued. Now the field is foreign trade. The struggle for supremacy is being waged with stubbornness. It is almost unnecessary to say that one of the chief contenders is Germany, which dominated the world in chemical production prior to 1914. Opposed to Germany, each in its own way, are half a dozen countries, the United States, England, France, Japan, Italy and Switzerland, whose chemical industries were forcedly developed during the war by the stoppage of Germany's exports.

Expansion of American Chemical Industries

American chemical industries have been developed marvelously in the last seven years, especially in regard to the production of coal-tar derivatives and synthetic dyes. By our progress we have put ourselves in a position where with proper legislation we shall soon be emancipated completely from the pre-war domination of the Germans. We are producing at this time 85 per cent. in bulk of our needs and importing 15 per cent. in the form of finer grades of material to the manufacture of which our industries have not yet been able to turn their attention. It is only a matter of time and opportunity before these grades will be made here. In certain staples, a comparatively large export trade has been built up, our shipments of chemicals including dyes, drugs, alkalis and acids in 1919 totaling \$133,000,000.

We are, therefore, in splendid strategic position to cope with the German in this world-wide chemical warfare of peace time. But I believe that the American chemical producer, if he be permitted fully to develop this industry, should do more than merely hold



JOHN J. RASKOB

Vice-president, E. I. du Pont de Nemours & Co.

his own in this country. I believe he should go into the foreign fields in competition—in vigorous, sustained competition. As a matter of fact, he must build up a world-trade to support the work of developing the domestic industry.

Can he do this? Yes, I say most emphatically, he can.

Three elements enter into the question of success in venturing into such world-wide competition. They are:

Are we equipped to produce in the required quality and quantity?

Do the foreign markets exist?

Can we furnish the credits?

A brief survey of the situation will answer these questions in a manner that should leave no doubt in the mind of anyone.

The American Chemist

Let it be stated at the outset that the American chemist has no superior in any country. He has proven himself a dependable, resourceful character in the emergencies of the last decade. We have, it is estimated, 20,000 trained chemists in the country. The number of skilled

factory workers in the industries is nearly 200,000. Since 1914 hundreds of new laboratories and manufacturing plants have been built throughout the country. The investment in plants for dyes and coal-tar derivatives alone since 1914 has been \$100,000,000.

Millions are being spent on experiment each year, the total for two of the largest companies being a round million. To give an idea of the progress that has been made it is only necessary to cite the synthetic dye industry, which, amounting to practically nothing before the war, has been developed while the war blockade kept out German dyes to the point of producing \$62,026,000 worth of dyes in 1918. The synthetic drug industry, based like the dyes on coal-tar crudes, produced nearly \$8,000,000 in drugs in 1918, whereas its pre-war production was negligible.

American Resources

Uneconomic practices, such as the beehive coke ovens, rapidly are being corrected. The establishment of by-product ovens naturally followed the new demand for coal-tar and the American chemists are now enabled to utilize the valuable by-products. This saving will contribute enormously to our facilities for producing in quantities sufficient for export.

America's vast coal supplies, its water-power for the development of electricity which is associated closely with all chemical development and its other natural resources place it in an enviable position from a chemical manufacturing viewpoint.

Coal is an absolute essential in chemical processes. For the lack of it, Italy is not generally considered as a serious competitor in the world chemical trade. And because she has coal deposits at her command, Japan, on the other hand, is looked upon as a competitor of no mean potentialities.

A great part of Norway's chemical plants are run by electricity obtained from "white coal," and there is no reason why we should not harness our rivers and falls to the same end.

Then, too, in considering the equipment of the United States to enter into a chemical trade struggle, there is much encouragement in continuing in various parts of our country discoveries of chemical raw materials heretofore imported and in the development of machinery for use in chemical plants. We have developed a chemical porcelain industry, a thing absolutely under the domination of the Germans before the war. The chemical glassware industry is in its infancy here. There are enormous possibilities in the fixation of atmospheric nitrogen, in the development of our potash resources and in the more intensive utilization of all our basic raw materials.

German Dye Production

There is at this moment much comment on Germany's ability to operate her dye factories to the extent to which it is known they are operating. Experts attached to the Allied Reparation Commission have reported that Germany's production of coal-tar dyes in January reached 12,000 tons, or 750 tons more than the pre-war monthly average. That country, according to these same experts, is now exceeding pre-war production of coal-tar dyes, and by the end of February had surpassed the production of fine chemicals prior to 1914.

In view of the Peace Treaty coal requirements from Germany, in view of the complaints that the people have not enough coal to keep themselves warm, the question arises as to where Germany is getting the coal necessary for such production. And will she be able to continue at such a rate for an indefinite time? But no such question of coal ever arises in a discussion of the chemical industries of the United States.

Export Markets

Now comes the question of the available markets. I believe it will suffice to give a list of the countries which in 1919 took American aniline dyes to a total value of \$10,742,000: France, Greece, Italy, Netherlands, Norway, Portugal, Russia, Spain, Sweden, England, Canada, Mexico, Cuba, Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Peru, Uruguay, Venezuela, China, British India, Dutch East Indies, French East Indies, Hong Kong, Japan, Australia, Philippine Islands and British South Africa. The exports for the first six months of 1920 were more than for all of 1919.

Pretty much the entire world is represented in that list, but to keep the foreign market we will be compelled to fight harder in the future than we have in the past. Germany is coming back into the field. Japan is now a producer of dyes and is protecting her new industry so that it can develop rapidly. France is doing the same thing and England has just put into effect a law which bars out all foreign dyes except such as are specially licensed because her manufacturers are not as yet producing them.

Manufacturers here, without such legislation, will be forced to meet the old German competition as well as that of the new dye manufacturing nations. We, therefore, are all the more in need of profitable foreign markets to sustain the industry while it is in the developing stage.

Export Trade Financing

The foreign market does exist, but it must be cultivated most carefully. The countries which need our products most, which offer the best opportunity for expansion of our exports, have not the money with which to pay on the pre-war plan of doing business and the American producer is not in a position to finance his own sales in a way to meet the new demand for credit. This applies to the American chemical industry just as it does to all others. The need is for a new kind of financing if these industries are to continue in the foreign field. It should be a comfort to the chemical industrial leaders to know that just at this time their fellow-manufacturers throughout the country, producers in all lines, farmers and bankers, are taking steps to facilitate the foreign trade of all by providing the necessary credits.

Development of the foreign markets for chemical products as well as all other products soon will be possible by reason of the organization of such corporations as the Foreign Trade Financing Corporation. In my opinion, this corporation will be a source of great aid to the development of our manufacture of dyes, drugs and organic chemicals. They have now become known in markets heretofore controlled by Germany, and to see them fall out of the running would be a sad spectacle.

Its Procedure

Now, to hold these new markets and develop them in the face of competition from Germany and the other chemical producing countries is a matter of credit. American dyes are liked, but undoubtedly the Germans and the others will offer credit concessions. It is there that the Foreign Trade Financing Corporation will come in. It will grant a loan to the buyer in foreign markets for the purchase of the American goods on long-term credits, and this loan will be secured, say by the paper of the purchasing country's established industries. Thus the product of American chemical workmen will be sold abroad, the money will remain in this country and America will have an investment in a high-grade foreign industry.

I have here touched only on those branches of the chemical industries having to do with the manufacture of dyes, pharmaceuticals, alkalis, acids, etc. Broadly speaking, the chemical industries include all those industries wherein chemists and chemical engineers are engaged in supervision of manufacture or in the construction and operation of plants. The products of the chemical industries are consumed by all industries, and thereby are affected by all the cumulative direct and indirect influences that determine prosperity.

Import Valuation of Foreign Chemicals

By Henry Howard

Chairman, Executive Committee,
Manufacturing Chemists' Association of the United States

PRESENT economic conditions demand a new standpoint in our consideration of the traditional American policy of fostering domestic production by a protective tariff.

The chemical industry appreciates the extent and stability of American industrial progress and the world responsibilities inherent in our transformation from a debtor to a creditor nation. In tariff legislation as it affects the chemical industries we do not insist upon what we do not need nor ask for what we need in a way to repel good judgment and general acquiescence.

The political principle that has contributed immeasurably to our industrial progress today is served not by a prohibition that works a restriction upon the outlet of our surplus production by inspiring retaliation, but by a fair equalization of production costs to which no aspirant for a share in the world's commerce can take umbrage. We want that equalization to contribute to the maintenance of the American standard of living without impairing American initiative or relieving us of the needed stimulus to efficiency in production.

The embargo of war compelled the development of certain American industries which the national instinct of self-preservation demands shall be fostered against an invasion that looks furtively beyond the amenities of trade.

In other branches of our industry the national welfare is promoted by insistence upon fair competitive conditions.

We appreciate the difficulties, under the present conditions of abnormal exchange, depreciated currencies and a present sub-standard of living alien to American experience and beyond our conception, in arriving at a determination of foreign production costs and see no early prospect of adjustment and improvement in these conditions that would warrant the retention of former practices in the assessment and collection of import duties.

At the first hearing on the Chemical Schedule, the House Committee on Ways and Means, January 6, 1921, I had the honor of presenting the brief of the Manufacturing Chemists' Association, which included a recommendation that domestic valuation instead of foreign valuation should be used as a basis for calculating ad valorem rates, or for any rates that are in any way regulated by the value of the imported article.

My recommendation aroused considerable discussion which indicated the importance of the subject in the light of foreign economic conditions and compels consideration of the criticism which assumes two main points of attack, viz., (1) the difficulty of determining the domestic value, and (2) the fear that acceptance of domestic value might conflict with commercial treaties.

I. Difficulty of Determining the Domestic Values

Perhaps the best short answer to this criticism is that whatever difficulties may be encountered in obtaining a fair domestic value they can never be so great on the average as the difficulties encountered in obtaining a fair foreign value. The proof of this is the flagrant undervaluations that are continually taking place in articles covered by ad valorem rates and which, although in

general well known, are practically impossible to prevent, owing to the difficulty of investigating facts and conditions in foreign countries.

The question as to the best means of determining domestic value is not a new one—it belongs to the administrative section of the tariff. The Underwood Bill, Section III, Par. L, attempts to lay down a procedure for the determination of domestic value when foreign values are unobtainable. In the brief submitted by the Manufacturing Chemists' Association to the Committee on Ways and Means on January 6, 1921, and as set forth in the January *CHEMICAL AGE*, the Underwood Paragraphs R and L, Section III, were taken as a basis, but slightly modified to meet the present situation.

This procedure provides essentially that whenever imported merchandise is subject to an ad valorem rate of duty, or to a duty based upon or regulated in any manner by the value thereof, the duty shall be assessed upon the actual market value or wholesale price thereof, at the time of exportation to the United States, in the principal markets of the United States; that such actual market value shall be held to be the price at which such merchandise is freely offered for sale to all purchasers in said markets, in the usual wholesale quantities, . . . including the value of all containers or coverings, whether holding liquids or solids, and all other costs, charges and expenses incident to placing the merchandise in condition, packed ready for shipment.

In the event that the actual market value can not be ascertained to the satisfaction of the appraising officer, the Act provides that he shall ascertain the cost of production of such merchandise at the time of exportation to the United States.

In my cross-examination Representative Garner of Texas raised the question as to whether the fair market value should be that of New York, New Orleans or San Francisco. We believe that the fair market value for purposes of assessing duty must be the same for all ports of entry on a given article at a given time, irrespective of any local conditions that might affect the value at a particular port of entry.

The law could well include provision for a Valuation Board whose duty it should be to decide from time to time as to fair valuations for the purpose of assessing duties. The public in this matter would be well represented by the conflicting interests always present; the importer who will always be bringing forward as many facts and arguments as he can in favor of lowering the domestic value and the American producer on the other hand submitting facts and arguments for increasing the domestic value.

Under these circumstances it would seem well nigh impossible for any radical error to be made, while in the case of foreign valuation even in a nearby country like Canada glaring errors are uncovered which make you realize the magnitude of the loss in revenue the Government must be sustaining from the thousands of cases of undervaluation which never come to light. The following incident, which was recently described by a Government official, is pertinent:

During the early days of the war, both Canada and the United States were exporting horses to Europe in competition with each other, and presumably the prices

received by each country were approximately the same, which was about \$270 each; yet during that period all the horses imported from Canada, that paid the ad valorem duty, were valued at an average price of approximately \$27, or only one-tenth of what they presumably were worth.

II. Domestic Valuation Might Conflict with Commercial Treaties

Another criticism which, if justified, would be a serious one, is that the plan of using domestic valuation as a basis of assessing ad valorem rates would be objected to by our State Department on the ground that it might be in conflict with our commercial treaties with foreign countries which provide in substance that there shall be no discrimination and that each country shall have the same privileges in trading with us as any other.

In other words practically all of our commercial treaties include a "most favored nation" clause. The thought of the opponents of American valuation apparently being that it supersedes a system wherein the domestic value in each of the foreign countries is taken as the basis and that therefore with foreign valuation as at present each country is treated exactly alike.

If this contention were true then we must admit that our present system of specific duties is the grossest discrimination because we charge the citizens of each country sending goods into the United States exactly the same rate when figured in money per unit quantity of the article imported, irrespective of the probable fact that the market value of the article is widely different in different countries.

The opponent of domestic valuation, i. e., the importer, might well say if he were consistent that a sliding scale for specific duties should be provided whereby the country having the lowest market value and therefore presumably the lowest costs for a given article should be given a preferentially lower specific rates than its neighbor, with higher costs and therefore higher market values.

This is exactly what we are now doing with our ad valorem duties based on foreign valuation. I maintain that besides being bad for the United States the system is the grossest discrimination against the countries having the higher costs and must result in many cases in practically barring them from doing business in this country. Careful consideration of this point will show that the old system of foreign valuation is in fact discriminatory in a most marked and unfair manner.

Take a concrete instance: phenolphthalein is offered in the United States today by German producers at 68 cents per lb., 25 per cent. ad valorem, duty paid, which would make the market price in Germany about 55 cents per lb. The market price in England on phenolphthalein is \$1.50 per lb. and 25 per cent. ad valorem duty would be 37.5 cents per lb. or a differential against the British product and in favor of the German product of 24.5 cents per lb.

Is not this discrimination of the grossest sort which would be entirely obviated if the domestic valuation in the United States were used for all alike. Ad valorem duties, combined with domestic valuation as a basis, is in fact the nearest approach to Specific Duty in the many cases where a specific duty is not practicable. I believe its fairness and desirability is so evident on studying the question that it should be made a law, irrespective of party lines, because it is just as necessary and just as desirable in a tariff for revenue as in a tariff for protection.

Conclusion

I feel very strongly that the valuation should be the same at all ports in the country at the same time, and that it ought not to be changed from day to day, but probably from month to month, and in order to give the rates reasonable stability a Valuation Board should be required to make use of the average selling price for the preceding three months in order to determine the new price for the coming month. In other words the system should be substantially the same as that which I understand is now in use both in France and Belgium, using a "declared domestic value," as the basis for calculating ad valorem rates.

The British Government Chemist

Sir Robert Robertson, K.B.E., F.R.S., M.A., D.Sc., F.I.C., Director of Explosives Branch, Research Department, Woolwich, has been appointed British Government Chemist in succession to Sir James Dobbie, retired. Sir Robert, who is fifty-one years of age, was educated at Madras Academy, Cupar and St. Andrews University. He was for some years chemist in charge of the laboratory at the Royal Gunpowder Factory, Waltham Abbey, and subsequently became superintendent of chemistry in the Research Department at Woolwich. He received his degree as Doctor of Science and his Fellowship of the Institute of Chemistry in 1897.

Excess Profits Tax and Lindsay Light Co.

The harmful influence upon industry of the Excess Profits tax, the repeal of which early by the next Congress reasonably is assured, is illustrated by the experience of the Lindsay Light Co. of Chicago, Ill., engaged in the manufacture of incandescent gas mantle chemicals, mantles and lamps.

President James M. Sherburne in circulator dated at Chicago February 15 says in substance: For the fiscal year ending May 31, 1918 we made a net profit of \$728,524, on which our total Federal taxes as computed by experts, without considering our special circumstances, amounted to \$408,816, or about 54 per cent. of the total earnings. The U. S. tax laws permit special assessments in cases where, with conservative accounting, the taxpayer would be discriminated against as compared with other similar concerns.

On Nov. 5, 1918 we paid \$100,000 on this tax. We are now in receipt of information which, while uncertain, indicates that the assessment may amount to nearly \$250,000 in addition to the \$100,000 already paid. The directors propose to appeal if any such amount is actually assessed.

For the year ending May 31, 1918, we laid aside a reserve of \$200,000 for such tax, \$100,000 of which, as before stated, has been paid out, and a further considerable portion was absorbed in meeting taxes for 1917 not covered by the reserve for that year; the remainder, without being specifically named, has always been contained in our surplus account.

For the foregoing reason, your directors do not feel that any further dividends should be paid on common stock until this matter is settled and liquidated. While this levy, if assessed finally, will, under present business conditions, absorb all the earnings for this year, and possibly for some time thereafter, the strength of the company and its earning capacity will not be impaired except so far as very bad business conditions may affect all firms.

Flour Milling and the Cereal Chemist

By R. Wallace Mitchell

President, American Association of Cereal Chemists



R. WALLACE MITCHELL
President, American Association of Cereal Chemists.

THE development of a primitive art that required the friction of one stone upon another to a highly centralized manufacturing practice evolved by the mechanical engineer and compelled by the exigencies of distribution, is coterminous with the growth of civilization itself.

The history of flour-milling not only epitomizes the history of the race but reflects in the intimately essential character of its product the play of the economic forces that underlie civilization and which operate with increasing efficiency in its service.

Our wheat crop averages annually about 800 million bushels. About $4\frac{1}{2}$ bushels of wheat are required to produce a barrel of flour. Our per capita consumption of one barrel per annum; to which may be added an export of about 10 million barrels to arrive at an annual production of 120 million barrels of flour. At a valuation of \$10 per barrel we arrive at one billion 200 millions of dollars spent annually on the basis of recent figures for the main product of the milling industry.

The geographic distribution of the milling industry and the growth of its strategic centres of production are factors of population, power and transportation, representing the maximum equilibrium between markets, manufacture and proximity to the raw material. The prestige of Minneapolis as the milling center of the United States arises from the completeness with which the requirements of the industry are satisfied at that point.

The development of natural gas and petroleum resources, however, has in a large measure deprived Minneapolis of the advantage inherent in water-power. Accordingly grain-growing regions of the southwest equally favored in transportation facilities have developed milling centers of great productive capacity at St. Louis, Kansas City, Salina and Wichita.

Less pronounced is the concentration of milling interests in the central wheat-growing area of Illinois, Indiana and Ohio where east and west lines of transportation discourage the centralization favored by radiating or converging lines pronounced in the trans-Mississippian area. Accordingly in the former region in 1919 there were 988 flour mills against 212 in the region tributary to Minneapolis, yet the production in that year was respectively 16 million and 28 million barrels of flour.

New York State, consuming more flour than it produces wheat and favored not only by long-haul advantages from surplus producing areas but by proximity to markets with low distribution costs, ranks third in flour production to Minnesota first and Kansas second.

The economic forces effecting the elimination of the neighborhood mill and therefore the centralization of the industry in more favored regions permit the division of the United States into two regions as appears in the accompanying map.

In addition to centralization of the industry, has come increase in size of the producing unit, all in obedience to natural law in the work of production, that demands in a competitive system progressive efficiency that the needs of man may be met in ever larger volume at lower cost per unit of product.

The Ideal of the Miller

The ideal of the miller is to make a flour that is absolutely uniform from month to month and year in and year out. He endeavors to maintain the same granulation in the various grades; the same "dress," i. e., degree of purification, and the same characteristics in bread-making qualities. He must go into the market and select wheat of such character that when blended and milled his product will be exactly like it was six months or a year previous.

It is necessary to accumulate in storage the types of wheat necessary to maintain his blend at all times; most mills have storage capacity sufficient for sixty days to six months and in many cases even longer. The small mill usually depends on local wheat but the larger mills draw their supply from many districts over a large area. Here the advantage of the large unit is very material in that the quality of its product can be sustained irrespective of unfavorable conditions in any particular locality.

The desire of the miller to produce an article of the best possible quality has induced engineers to perfect many devices for improvement in manufacture. The past 75 years have seen the development of milling efficiency to a point where it is so fine that any new improvement can no longer make a decided advance in the quality of the product. Mill owners became aware of this some years ago and the more progressive of them in their search for commercial advantage turned to the science of chemistry.

Here is presented the spectacle of an industry that having exhausted the ingenuity of one class of technical men to improve its product turns to another.

Pioneer Cereal Chemists

The foundation of the application of chemistry to the art of milling was laid by such men as Guthrie, Fleurent, Osborne, Vorhees, Snyder, Wood and Teller. The attainments of these men and their contemporaries from 1890 to the early years of the present century did much to increase our knowledge of cereal chemistry and great credit is due to them. These men, the pioneer cereal chemists, studying flour and wheat from academic motives had co-ordinated facts in their study of cereal products and their results form the basis upon which men in the industrial phase were able to build.

Chauncey Foster who had charge of the laboratory for the Northwestern Consolidated Milling Co. in Minneapolis as early as 1906 was one of the first to operate a control laboratory for a milling company. Frank W. Emmons about the same time had and still has charge of the laboratory of the Washburn-Crosby Co. These men were the first to make serious application of the data compiled by the earlier investigators in connection with milling operations. Somewhat later Professor Harry Snyder deserted other fields and took charge of the laboratory of the Russell-Miller Milling Co., Minneapolis. Other well-known chemists in this field are M. A. Gray of the Pillsbury Milling Co., Minneapolis; H. E. Weaver of the Larabee Flour Mills Corporation, Kansas City; A. R. Sasse of the Southwestern Milling Co., Kansas City, and H. A. Porter of the New Prague Flour Mills Co., New Prague, Minn.

These men have seen the flour laboratory develop from an experiment to an essential cog in the organization. With the exception of only one they are all still actively engaged as chemists. They were employed by the most progressive firms when a laboratory truly was an experiment. The success with which their efforts met was the beginning of the movement toward chemical control in the mill that has continued until today most mills making in excess of a thousand barrels of flour a day employ chemists.

Responsibilities of the Cereal Chemist

In the beginning there was a dearth of chemists acquainted with cereal products and the milling process and the demand early reached proportions much in excess of the supply. Development came too fast for the unalloyed good of the chemist; he was called upon for more than he was prepared for. Without standard methods or uniform means of expressing results it was but natural that confusion should result.

To add to that confusion there sprang up "quick process" schools that undertook to make a cereal chemist out of a high school boy in six weeks. It was inevitable that dissatisfaction should develop with chemical reports as they became more common in the business considerations of the flour-mill management.

It may be said, however, for the cereal chemist that he has met the situation in a very creditable manner. By means of organization and discussion he has made great strides toward uniformity and accuracy in laboratory analysis and interpretation of results. The Society of Milling and Baking Technologists and the American Association of Cereal Chemists were organized for the specific purpose of stimulating research and standardizing methods of analysis. Their members, having an intimate knowledge of the requirements of the industry, have led the way in applying chemistry to the problems of the cereal food manufacturer.

The milling chemist is a specialist yet his field is rather inclusive. He must have an intimate knowledge of a raw material of a complex character, a thorough understanding of the mechanical processes of milling and an acquaintance with the art of baking in all of its many variations. His responsibility begins with the selection of the wheat and ends only when good bread is produced from the flour. To guide the wheat buyer, assist the miller and advise the baker are duties always with him and each one lies in a different field.

What Is Wheat?

Outside of the trade "wheat is wheat." Even the farmer treated it as such in the past, but today, because of the more intelligent demands of the miller he is exercising more care in the selection of seed. The several

general classes of wheat widely grown in the United States may be designated as "soft," "hard," and "durum." Government standards for wheat recognize six major classes and fourteen subclasses and all business in wheat is based on these standards according to its purity, moisture-content, weight, freedom from foreign material and soundness or infection of smut or rust.

Durum Wheat

Durum wheat is very hard and flinty; characterized by high protein content, resistance to tempering for milling and the bright yellow color of the flour produced from it. It is used largely for the manufacture of macaroni, noodles and similar paste products; it makes a poor bread-flour. It is a "spring" wheat, i. e., the crop is sown in the spring of the year.

Hard Wheat

The "hard wheat" class is the most desired for bread-making flour and as a result is produced in greater quantities than the other varieties. Hard wheat is the major wheat crop in the northwestern states and the southwest. Where winter is severe the "spring" varieties are grown; in Kansas, Oklahoma, and other localities where the crop will not winter-kill the fall-sown or "winter" varieties are preferred. This crop affords excellent winter pasturage for live stock and is much appreciated by the farmer. To one not acquainted with the facts it might seem poor policy to let stock pasture on the growing grain but the reverse is true. The effect of turning the stock into the grain is to cause it to stool better; i. e., it stimulates the plant to send up more shoots and the result is that a larger yield with less rank growth is attained. The hard wheat whether spring or winter variety is the most desirable crop for the production of bread-flour. The protein-starch ratio is such that the flour produced from it has the qualities most desired by the baker of leavened bread.

Soft Wheat

Soft wheat, like hard wheat, is grown over a large range of climate and it also includes "spring" and "winter" types. In contrast to the other types it is characterized by being much starchier and relatively soft or mealy. In milling it is more difficult to separate the flour from the bran but on the other hand it produces a very white flour. Being lower in protein-content it is eminently suited to the making of biscuits, cakes, etc., where the leavening agent is a chemical compound. We find soft wheat grown as a principal wheat crop in nearly all sections excepting the northwestern states and the southwestern wheat growing region including Colorado. The central states of Ohio, Michigan, Illinois, Indiana, Kentucky and Tennessee grow the major portion of the soft wheat of the country.

Flour Characteristics

Each class, type and variety of wheat has certain characteristics adapting it for bread-flour on the one hand or cake-flour on the other. Hard spring wheats of the Northwest and the hard winter wheats of the Southwest are the most desirable for bread-making purposes. They produce flour that withstands considerable fermentation and is strong enough to yield a large loaf of good texture, retaining when baked sufficient moisture to make a decidedly palatable loaf. A patent flour from such wheat usually will contain 11-12½ per cent. protein. The soft wheat, on the other hand, yields flour having less than 11 per cent. protein and sometimes as

low as 7½-8 per cent. Such flour will not withstand vigorous fermentation or much physical abuse in the dough; since fermentation is necessary to produce gas which gives lightness to the bread it is evident that it is unsuited for panary fermentation.

Where aeration is accomplished by the use of chemicals such as soda or baking powder it is desirable to have a flour of low protein-content as that will lessen the resistance of the dough and consequently the amount of leavening agent required. Soft wheat flour is generally used for cake-making and in the pancake and biscuit trade. The cake flours of the mid-central states are much sought for because of these properties just as the strong hard wheat flours are in demand for bread-baking. The greater portion of the wheat raised in the east coast states as well as that from the Pacific Northwest is soft in nature although it is usually not as white as that from the central states. Climatic conditions and the nature of the soil are important factors governing the nature of the wheat grown in any particular locality. These conditions and the advantage of winter pasture oftentimes offset the lesser market value of the soft wheat in the production economy of the farmer in stock-raising regions.

Chemical Control in the Flour Mill

The vast majority of milling companies confine themselves to the manufacture of flour either from soft or hard wheat as they cannot be blended and ground together. Policy or location governs the kind of wheat to be ground. The duty of the chemist is to aid in producing a superior product suited to the trade to be served. He selects and blends varieties of wheat that will give the results most desired; it devolves on him to see that conditions most suitable for the blend are maintained. He determines the correct period for tempering and the milling and baking qualities of the flour by milling a portion of the mixture in an experimental mill. He tests the finished product from the plant and must be satisfied that it is of the proper quality.

The usual daily tests in the mill are: moisture of the wheat at different stages of conditioning; moisture; protein and ash of the flour; moisture of the feed; color and dress, i. e., freedom from dirt, bran specks, etc.; and the baking test which establishes the fermentive rate, strength and color of the bread, the soundness of the flour and the freedom from foreign odors.

Consideration of the Raw Material

The most desirable condition is to have heavy, sound wheat of one class and without admixture of foreign grain, such as rye, barley, oats, etc. This condition is seldom met with in the larger mills; not often is a crop all heavy and sound and still less often is it free of extraneous material such as mentioned above.

It is usually true that the longer a region has been

planted to wheat the greater is the contamination with natural impurities. The hard spring wheat of the Northwest has great quantities of mustard, cockle, vetch, wild oats, rye, buckwheat and kinghead. The Southwest produces much cleaner wheat, it not having much mustard and cockle and practically no buckwheat or kinghead. In the central soft wheat region, considerable wild onion and "false wheat" are found in the crop.

Fungus infections that cause considerable trouble to the miller are smut and bunt. They are spore-producing; the spores are nearly black and have a strong characteristic odor. It readily can be understood that such an impurity would cause much worry to the miller producing a pure creamy-white product. Smut is more or less prevalent in all sections but varies in the degree of infection from year to year.

Unsound and frosted wheat very seldom reach large proportions of the total wheat crop. Occasionally when the weather has been very wet during the cutting and harvesting period considerable quantities of the wheat coming to market will show evidence of the beginning of germination, but very seldom is the condition so general or prolonged as to affect the whole crop. Frosted

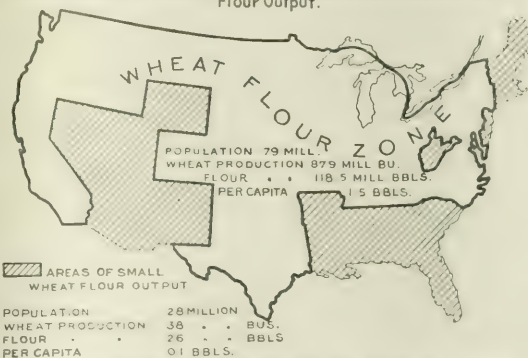
wheat is rarely on the market in amount sufficient to be noticeable. Either form of damage has a very serious effect on the fermentive qualities of the resultant flour. Dough made from such unsound flour is always characterized by a rapid fermentation, usually a decided stickiness, and if very pronounced will produce a loaf heavy and coarse in texture and flat and irregular in shape.

Classifying and Blending Wheat

Wheat when received at the mill for storage is usually classified according to its milling properties; thus, wheat of average weight is binned in such a manner that the portion high in protein will be separate from the blend average and the same will be the case of that portion high in moisture or which is smutty or unsound. By such an arrangement the "high" and "low" protein portions may be later blended and the inferior portions used in such small quantities as to be absorbed without producing undesirable results.

To mill wheat to the best advantage it is necessary to "temper" or "condition" it by the addition of water after which it is allowed to stand for a period of time which varies with the character of the wheat; soft wheat requires from a few minutes to three or four hours and hard wheat sometimes receives as much as forty-eight hours treatment. The usual time allowed for hard spring wheat is less than fifteen hours and for hard winter wheat a few hours longer. The method of milling, character of crop and the tempering capacity of the mill govern the time of conditioning. The object of tempering is to get the bran-coat of the wheat in a condition so that it will not pulverize and at the same time to

MAP OF THE UNITED STATES
Showing the Wheat Flour Zone set off from Areas of Small Wheat Flour Output.



Every state included in the wheat-flour zone has at some time produced more than a million barrels of flour out of its own grain. No state included in the shaded area has ever produced a million barrels in a single year, any one year, even in the case of half-million barrels. The wheat-flour zone produces 118 million barrels, the small production (shaded) area less than 3 million barrels, respectively 1.5 and .1 barrels per capita. The former area supplies 50 per cent. more flour than it needs; the latter area supplies only .1 of its own needs.

avoid excessive water or time which would permit moistening the inner portion of the berry and cause it to "wool up" in the process of reduction to flour.

The milling process reduces the properly tempered wheat to flour and bran, the former in grades determined by the degree of contamination of the latter which, to secure the best separation, should be tough and not brittle.

Ash Tests

Pure bran is higher in ash than pure endosperm which fact is used in classifying correctly the streams of stock in the milling process as well as in detecting and locating sources of trouble when they occur. Really pure soft wheat middlings of first quality may run as low as .25 per cent. ash or lower; hard wheat middlings of the same quality will usually run about .07 per cent. higher; bran will have 5-6 per cent. of ash; so it is seen that bran contamination may readily be detected as well as the presence of dirt when occurring in the flour streams. The ash test is one of the most valuable tests in mill control and also in general estimations of flour quality but must not be used with too much emphasis when the history of the flour is not known as the natural ash of different wheats varies to a considerable extent.

The laboratory aids the miller in maintaining uniform conditions in his stock by making frequent determinations of the moisture content of the mill-blend before and after tempering, as it is fed to the rolls, and on the finished products. By making frequent ash tests of the flour, assurance is given of the proper functioning of all of the machinery and warning given when faults develop in sifters, purifiers or roll adjustment.

Flour Grades

In making flour from wheat the miller endeavors to remove as much as possible of the inner portion of the berry from the bran in the form of granules. The flour resulting from the more highly purified streams is the whitest in color, the best in baking qualities and for most all purposes is the most desirable. Such flour is called "Patent" and as such sells at the highest price of any of the products of milling. All of the other streams of flour in the mill excepting about three per cent. of the very poorest goes to make another grade of flour called "clear" and is a product neither so white, nor so even in granulation nor does it have the good baking properties of the patent flour. It commands a much lower price on the market and at that it is necessary to look to foreign fields for a market.

Other separations of stock are made according to conditions, prices and the miller's fancy. The aim of the miller is to remove all foreign material as well as all bran from the flour in the milling process; both are detrimental to quality and both are indicated by chemical analysis. The presence of either form of impurity increases the ash content of the flour; the dirt affects the color and the brany particles will affect fermentation. Good milling leaves no bran in the flour and it also removes nearly all of the flour from the bran.

Baking Test

Determinations of sugar, acidity, fibre, fat, etc., are not usual in laboratory routine. The baking test supplies a means of detecting irregular conditions due to abnormal proportions of these constituents and as it is simple, quick and inexpensive it is usually relied upon. It indicates the fermentive rate of the flour, strength and water-absorbing property and from the finished loaf is gained information as to its ability to produce a fine grained, bright, light, normal-tasting loaf of good volume.

Feed Control

Routine inspection of feeds is usually limited to the moisture determination daily or oftener and a complete analysis at regular intervals. From the miller's standpoint the feed should be high in crude fibre, fat, and protein and low in carbohydrates. The trade, of course, desires a product low in fibre and high in the feeding-value constituents but the miller makes feed as a by-product only and its quality will be such as may result from efficient flour extraction.

Several factors have a bearing on the salable and keeping qualities of feed. If produced from smutty or musty wheat the odor is offensive; if packed with too high moisture-content it quite readily spoils and spoilage is still more probable where the feed is very tightly packed. Certain kinds of weed seeds or stem joints if mixed with the feed will lower the quality very much by the odor produced by their presence. This latter condition occurs more often when the practice of grinding the screenings and adding them to the feed is followed.

Government Inspection

Nearly all states have well-defined laws and standards pertaining to feeds and they maintain inspectors and laboratories to check up the material on the market. Feeding material is more commonly adulterated and misbranded than flour, a condition that has been the factor in causing close inspection.

Flour being a product more readily appraised by the dealer and consumer is subject to much less rigid inspection. Sophistication by the use of starch, corn flour or other fillers of lower value is prevented by federal pure-food laws and also by the fact that most any adulterant exercises a degrading influence on the quality of the flour which is readily detected. The practice of using bleaching agents on flour is a common one but like the custom of bleaching muslin it is resorted to merely to satisfy the eye of the consumer. The bleaching agents most commonly used are chlorine gas and the nitrogen oxides produced by the electric spark in air.

Color of Flour

The color of patent flour of low extraction (fine patent flour), varies with the type of wheat used. Certain soft wheat patents have a very white color approaching that of corn starch; much of the flour from the soft wheats in the central regions and Michigan are of this type. The hard spring and winter wheats yield a flour that is slightly creamy and for many years this clear, bright, creamy tinge was considered a sure indication of superior quality with the bread-baking customers. It is still so considered by all who know good flour but in the present day much flour of equally high grade is bleached to a clear white color to satisfy the demand for whiteness.

Of a deeper shade of yellow is the unbleached flour from certain wheats known as "yellow berry" which is found in both soft and hard wheat districts. Flour from Durum wheat is always a bright yellow but with this flour the color is a distinct asset as it is largely used for the manufacture of macaroni, noodles, etc., in which the golden color is much appreciated. Variations in soil conditions and the weather during the period when the wheat is ripening influence the color of the flour produced from it. While much is to be learned of such influences yet it is known that dry seasons see flour of a generally lighter color and often the flour from wheat grown in bottom-land will be much creamier than the flour from the same wheat grown on up-lands.

Consideration of the Cereal Chemist

It is now apparent that the chemist has a place in flour-making which invests him with much responsibility and offers great opportunities. He is responsible for the maintenance of quality in the flour produced which means inspection and blending of raw materials, inspection and assistance in the manufacturing process, and the analysis of the final product to assure quality in all goods turned out. Further he must have a knowledge of the uses to which his flour may be put that runs all the way from making a superior bread or cake to the mixing of bill-board paste.

There is today an urgent demand for more complete and accurate methods of analysis. As stated above the baking test today is a very important one yet it is a most indirect means of getting at vital information; if it shows a sample to be very good, of course that is sufficient, but the difficulty comes when the bake turns out poorly. To trace the cause of poor results in a sample the chemist needs accurate and rapid methods for the determination of acidity, sugar, enzymic activity, the various protein bodies, and other factors. The field for research is extremely broad and the possibilities promising.

The average mill chemist today is so crowded with control work that he does not have much time for pure research. This condition will certainly be changed as chemical control becomes more universal and a larger number of chemists are drawn into the field. There are probably two hundred chemists in charge of mill laboratories today with probably half that many more men in educational institutions doing work that bears on the problems of the industry. This is but a handful when the total number of chemists in the country is considered.

There are several reasons why the number of chemists employed by mills is so limited. In the first place there are according to 1914 statistics only 218 mills that make 100,000 barrels of flour per annum and the expense of maintaining a laboratory and chemist is rather excessive for mills of less than 500 barrels per day. For a mill making 100,000 barrels of flour in a year it is evident that the cost per barrel would be at least three cents and in normal times three cents is an important item.

It is at this point that cost approaches the profit gained through increased efficiency. In the second place the number of commercial laboratories specializing in flour work makes possible a semblance of control which deters the smaller miller from making the more expensive investment. Still another factor is the condition that the flour trade has been in since 1914. At that time the value of the chemist was just coming to be generally acknowledged; then came the war and with it the disappearance of normal competition. With the resumption of normal peace conditions competition will create a demand for more and better qualified chemists.

The Baking Industry

The baking industry is now beginning to require chemists and it is but a matter of a few years until competition will force all large bakers to resort to the advantages offered by chemical science. An evidence of this is the "Bakers Institute" at Minneapolis which is under the direction of Dr. H. E. Barnard and supported by the master-bakers of the country. It was organized for the purpose of studying the problems of the baker from the chemical and fermentive standpoint. It will serve to show the baker that chemical control is necessary to the greater efficiency demanded by business conditions of today.

The Cereal Chemist and Flour Mill Administration

A condition unfortunate for both the chemist and the milling management is the relation that seems to exist almost universally in regard to the progression of the chemist to executive positions in the organization of the industry. The average mill owner views the chemist as a peculiar sort of being possessed of special knowledge, one who would not be of any value outside of the laboratory. He recognizes the fact that the chemist is trained in a special field and finds that it is cheaper to train a clerk in office management than to train a chemist.

The chemist on his part is usually absorbed in his science and does not seek to learn the business end or feels unwilling to make the sacrifice that is necessary to gain the knowledge required in the executive positions. Why there are not exceptions to prove the case I can not say but the fact that the chemist-manager is unknown is nevertheless true. The training of the chemist is well suited to prepare him to become milling superintendent and in a few cases such has been the case but as a general thing the inducement has not been sufficient to accomplish the end. Milling is an art that can not be learned from books; experience is the only teacher. To become a miller requires years of experience and though the chemist is eminently fitted to make a superior milling superintendent the road is too rough and the process too slow for most men.

The chemist usually occupies a position in the organization similar to the superintendent in that he is accountable directly to the management and this condition is as it should be. He shares with the head miller the responsibility for the production of flour that meets the standards. He must work *with* the miller to insure the full benefit of their combined ability. The miller relies on his experience, his senses of sight, taste and touch; the chemist relies on the results of chemical analysis. Neither method of judging flour can suffice if taken alone; no chemical means or laboratory apparatus can so certainly detect slight differences in granulation as will the trained skin of the miller's hand and no tintometer will detect color quality so readily as the experienced miller's eye; on the other hand the absorbing power and quality of gluten of a sample can only be determined by analysis.

Thus it is seen that the chemist in a very real sense is an integral part of the process just as one of the machines in the system is; without the chemist the quality of the product will be inferior just as the quality would suffer if a portion of the purifying system were cut out of the mill. In a sense the laboratory acts as a governor for the whole system; it is the means to maintain uniform conditions in the plant at all times and serves to insure constant quality which in turn builds up confidence in the mind of the trade and that in itself assures a steady demand.

The recent national convention of alumni of the University of Pennsylvania discussed the possibility of changing it into a State institution because of financial difficulties, deficit for current year being estimated at \$300,000. The faculty is in favor of State control.

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The General Ceramics Co., 50 Church Street, New York, will take bids early in April for an addition to its plant at Metuchen, N. J., to manufacture sanitary ware. It will be one and two stories, 165 x 785 feet, and is estimated to cost about \$400,000 with machinery. Dietrich Wortmann, 116 Lexington Avenue, New York, is the architect.

Centrifugal Separation in Soap Manufacture

IN Patent No. 1,367,973, application for which was filed May 8, 1916, and granted February 8, 1921, to Martin H. Ittner, chief chemist, Colgate Co., Dr. Ittner describes the application of the centrifuge as a substitute for the settling period in the manufacture of settled soap.

Progress in the art of soap manufacture is mainly along lines of mechanical improvement in handling the liquid finished soap direct from the kettle in which it remains after the completion of the boiling process for a period dependent upon the volume of the contents. This period is one of sedimentation and cooling, during which the mass resolves itself on completion into two sharply defined portions, respectively, the converse of the other in composition. The upper portion of "settled" soap consists of soap with a degree of hydration determined by kettle practice and usually in the proportion of two parts of soap to one of water. Into the lower portion, called from its color the "nigre," has been discharged the insoluble contamination, much of the organic coloring matter, practically all of the residual alkali used in the process and a proportion of dissolved soap dependent upon the character of stock used and the kettle practice.

The time required for "settling" represents not only a restriction of plant capacity but a tying up for the period of the capital involved in the cost of the material. The elimination of this period, with its consequent contribution to production efficiency, Dr. Ittner proposes by the introduction of the centrifugal machine whereby a high degree of continuity is introduced in the soap-making process. He says:

"I have found that the soap on the completion of the 'settling' change lends itself readily to continuous mechanical separation into two liquid layers. Continuous mechanical separation is of particular advantage for the reason, among others, that the settled soap and nigre are forced to rearrange themselves under the centrifugal action whereby the heavier nigre is forced to the periphery of the machine and the lighter settled soap forced inwardly nearer the center of the machine.

"The separation in a continuous manner, by the use of a continuously operating centrifugal separator of appropriate construction, has the further important advantage, that, by its use, large charges of soap such as are produced in soap kettles, can be passed rapidly, and in a continuous manner, through the centrifugal machine. Thus, large batches of soap can be separated in a continuously operating centrifugal machine of relatively small size, in a sufficiently rapid manner to permit separation of the whole charge even at the boiling temperature and in any event before it has cooled below the temperature at which the desired separation is most complete.

"By the old gravity settling process, the settling does not begin at once on removing the source of heat, owing to the strong convection currents in the hot soap that retard separation. Later, as these currents become less marked, owing to the cooling of the soap, the settling becomes more and more retarded, owing to the gradual stiffening of the soap due to cooling. The ordinary gravity settling, furthermore, does not remove much of the fine dirt or insoluble impurities and is less effective in removing the soluble impurities; considerable time being always required, amounting, for large batches, to as much as a week or more.

"According to the present invention, the soap, after the addition of sufficient water to make it thin enough

to flow freely as above described, is subjected to the centrifugal separating action and effectively separated into two layers, one of pure settled soap and one of nigre containing almost all of the soluble impurities not removed by the lyes previously separated from the soap curds. At the same time, much dirt or other insoluble matter not removed by gravity settling is thrown to the extreme periphery of the rapidly revolving centrifugal machine, thereby brightening up the soap appreciably. It will thus be seen that a more perfect separation is effected, in a short period of time, and while the soap is still hot or even near the boiling point.

"The impure soap or nigre obtained by the centrifugal separation may be promptly subjected to treatment with salt, salt solutions or lye, and again subjected to centrifugal separation, while still hot, whereby the greater portion of the soap contained therein is separated from most of its impurities."

The centrifuged soap as it flows from the separator is available for the customary treatment, according to the class or grade of product intended, as it would be on pumping from the kettle at the end of the customary settling periods.

Milwaukee Chemists and the Water Supply

J. W. Ellms, water works engineer, Cleveland, Ohio, was retained by the city of Milwaukee in 1919 to investigate her water supply and to make definite recommendations. His report, submitted in 1920 after exhaustive study, called for the construction of a filtration plant costing \$4,000,000.

Milwaukee chemists, represented by a committee of which George N. Prentiss, engineer of tests of the Chicago, Milwaukee & St. Paul R.R. is chairman and which comprises Ben S. Salomon, paint engineer Patton Paint Co.; C. A. Nash, research chemical engineer, Cutler-Hammer Co.; A. J. Schedler, chemist, Pabst Brewing Co.; John Arthur Wilson, chief chemist, and Erwin J. Kern, chemist, A. F. Gallun & Sons Co.; and R. M. Kibbe, chemist, Albert Trostel & Sons Co., assailed the conclusions of the report and demand on behalf of the public welfare the completion of a sewage-disposal plant at Jones Island.

While not condemning the principle of filtration, the chemists contend that to prevent contamination of the city's water supply is the sensible procedure over against the continuance of contamination and the expenditure of several millions to cure what could be prevented. While some form of filtration of the lake water eventually may be required, the chemists claim that preventive measures should be used to the limit pending the developments of research to determine what form of final treatment may be necessary. All of which sounds logical and so it impresses the Milwaukee people.

The notable thing is that a body of chemists are sufficiently public spirited to feel the responsibility of placing their special knowledge at the command of the public.

Following its practice of announcing notable additions to the list of domestic-produced dyes the National Aniline & Chemical Co. submits to American dyers "National" Erie Fast Orange C G, and emphasizes its ready solubility, good fastness to light, washing and alkalis, resistance to perspiration and organic acids and its suitability for dyeing light shades in a padding machine, used either as a straight dye or for shading purposes.

Secretary of the Treasury and the Mellon Institute of Industrial Research



ANDREW W. MELLON

THE appointment of Andrew W. Mellon as Secretary of the Treasury completes the recognition of technology in the list of cabinet advisors to President Warren G. Harding. If Herbert Hoover can be said to represent the technical element in production, Andrew W. Mellon represents the element that makes fruitful the plans of the technical man.

Aside from Mr. Mellon's connection as president of the Mellon National Bank of Pittsburgh, he is identified with the Aluminum Co. of America, the Carborundum Co., Koppers Co., the Crucible Steel Co., Standard Steel Car Co., Pressed Metal Radiator Co., and the McClintic Marshall Co.

Mr. Mellon is a '73 alumnus of the University of Pittsburgh, an administrative part of which is the Mellon Institute of Industrial Research, founded in 1913 by Mr. Mellon and his brother, as a memorial to his father, whose banking house he entered upon his graduation.

Mr. Mellon's experience as a banker and a manufacturer made him keenly appreciative of the economic value of the Industrial Fellowship System devised by Dr. Robert Kennedy Duncan in 1906 and placed first in experimental operation at the University of Kansas in January, 1907, and inaugurated at the University of Pittsburgh in September, 1911. In March, 1913, Andrew W. Mellon and Richard B. Mellon established it on a permanent basis.

The Mellon Institute of Industrial Research is an institution for the creation of technical knowledge desired by those who contribute to the expenses of its creation and owes its origin to a recognition on the part of far-sighted industrial leaders of the dependence of industrial progress upon scientific research.

Individuals, corporations and trade organizations support at this institution industrial scientists whose work is devoted to the solution of problems of direct practical value to the interests of those who provide the scientists' remuneration and the necessary apparatus and equipment needed in their work.

The Institute supplies the plant and facilities, selects the qualified investigator, and gives to the work of the investigator such guidance and supervision as shall be productive of results of the maximum practical value.

The relation between the Institute and the individual, or corporation, or trade organization is of a contractual character, whereby the latter, termed a Donor, contributes to the Mellon Institute a definite amount of money for a period of not less than one year, which must be adequate (1) to pay the investigators' compensation, and (2) for all necessary apparatus or equipment. This constitutes the creation of an Industrial Fellowship by the donor.

The nature of the problems whose solution is desired, or of the investigative work which it is desired to have undertaken, as well as the qualifications of the investigator himself, are matters of discussion and agreement between the officers of the Institute and the donor.

The Mellon Institute at the present time provides facilities and direction for the support of 35 individual and 12 corporate fellowships covering, e. g., such subjects as aluminum, coffee, food container, asbestos, toilet articles, synthetic resins, bread, enameling, leather belting, protected metals, collars, sulphur, dental products, copper, physiological research, quartz, oil, glass, gas, yeast, illuminating gas, glycerin, fibre, household utilities, zirconium, fish products, copper, silicate, fuel, silverware, magnesia, insecticides, organic solvents, coke, fertilizer, glue, metalware, distillation, fruit beverages, soap, laundry practice and refractories.

The sums devoted to the fellowships, the subject of many of which have just been enumerated, range from \$2,250 a year, with a percentage of the gross profits of the application of the results of investigation, to \$41,000 per year, determined in amount by the character of the work and the number of men required in its prosecution. The usual sum required for the establishment of an industrial fellowship appears to run around \$5,000-\$6,000 per year.

The knowledge acquired by the investigator is the property of the donor.

The Mellon Institute is in no sense a commercial enterprise, but exists solely to make science serve the practical needs of industry.



Mellon Institute of Industrial Research of the University of Pittsburgh

Many large corporations whose business rests intimately in applied science maintain research organizations of their own and by means of their own employees in their own plant laboratories do what Mellon Institute provides for those who are not thus equipped to solve the problems arising in their own plant, business or trade. The Mellon Institute derives no financial profit from its work, this being the sole object for which donors maintain investigators under its auspices.

The profit of the Institute, if it may be characterized as such, comes from the effectuation of the purpose of its founders, who saw that in promoting industry they could promote best the common welfare. A public benefaction of this character is in line with the philosophy of Andrew Carnegie—that the most effective form of philanthropy is to help people to help themselves.

Potash Production in 1920

RETURNS thus far received by the Geological Survey from the producers of potash in the United States during 1920 indicate that the output amounted to 167,346 short tons of crude potash salts, containing 48,625 short tons of actual potash (K_2O). The stocks on hand amounted to about 30,000 short tons of crude salts. The sales were valued at more than \$7,000,000. This material was produced at 65 plants. In 1919 there were in operation 77 plants, which reported an output of 110,243 short tons of crude salts, containing 30,845 tons of actual potash.

In 1918, 128 plants were in operation and made the largest domestic production—207,686 tons of crude salts, containing 54,803 tons of potash. The production in 1920 was therefore nearly 57 per cent. greater than that in 1919, but only about 89 per cent. of that in 1918. The subjoined table shows the sources of the material.

POTASH PRODUCTION IN THE UNITED STATES IN 1920

Source	Number of plants	Crude material (short tons)	Actual potash (K_2O) (short tons)	Percentage of total
Salines:				
Nebraska	11	85,245	20,934	43.0
Elsewhere	6	46,865	17,207	35.4
Cement dusts	17	132,110	38,141	78.4
Blast-furnace dusts	7	10,056	1,141	2.4
Waste from molasses distilleries	6	1,503	152	.3
Waste water from sugar refineries that use the Steffens process	4	9,420	3,253	6.7
Wood ashes	76	9,201	3,394	7.0
Alumite, silicate rock, kelp, and miscellaneous	10	294	200	.4
	5	4,762	2,344	4.8
	65	167,346	48,625	100.0

The table shows that the bulk of the output in 1920 was obtained from salines and, as in former years, the Nebraska lakes afforded the largest percentage. The company that made the largest output, however, did not operate on the Nebraska lakes.

About 200,000 short tons of potash (K_2O) was imported in 1920, and this quantity, with the 48,625 short tons produced in this country, made the available supply about equal to the quantity normally used in each of the five years immediately preceding the war. Because of the low price received for their produce many of the farmers of the country were unable to take up promissory notes given by them for fertilizer in the spring of 1920 and were also unable to buy the fertilizer they required in the fall.

This condition, coupled with the abundance of potash on the market, resulted in a cancellation by the fertilizer-manufacturing companies of orders for domestic potash and greatly reduced the prices of all potash fertilizer materials. As a consequence all the Nebraska plants were closed by the end of December. Most of the other 54 plants reported almost continuous operation during the year. Another hardship suffered by the Nebraska producers was the unprecedented rainfall early in the summer, which diluted the brines in the lakes so much as to make their concentration more difficult and more expensive. There is still considerable apprehension as to whether the domestic potash industry will be able to maintain its existence in the face of the renewed importation of potash salts.

International Chemical Co., capital \$150,000, 13 W. Saratoga street, Baltimore, Md., has been incorporated by Solomon F. Acree, Wade A. Gardner and Carlyle Barton, to manufacture chemical products.

Annette Abbott Adams and Dr. H. W. Wiley on Medicinal Beer

THE elation of the fermentation chemist at the ruling of Annette Abbott Adams, assistant attorney general of the United States in the late administration, in ruling that old-time beer and wine could be prescribed by physicians as medicine and that the Internal Revenue Commissioner was without authority to restrict the number of permits for the manufacture or sale of any liquor for medicinal purposes, will be short-lived if Dr. Wiley has his way. The probability that his opinion will find acceptance by the new attorney general, Harry M. Daugherty, is any one's guess.

A total of 436 breweries are now engaged in making beer containing less than one-half of 1 per cent. alcohol. If they are to be allowed to manufacture beer with 4 per cent. alcohol, not only is apparent the great encouragement to a much-perturbed chemical industry, but the necessity of increase in the number of physicians because of the demands of patients.

Dr. H. W. Wiley, former chief of the Bureau of Chemistry of the Department of Agriculture, in a statement addressed to the Attorney General, says: "From a theoretical point of view the ruling is doubtless correct. From a legal point of view I cannot express an opinion. From the medicinal point of view I agree to the Attorney General's opinion. However, this agreement has one reservation, viz.: Whisky, brandy and wine have not medicinal value. Have they a place, therefore, in any pharmacopoeia?"

"Beer is not mentioned among the articles in the Pharmacopoeia, ninth decennial revision. It is not found among the new and non-official remedies approved by the Council on Pharmacy and Chemistry of the American Medical Association. It is not found among any of the so-called patent or secret remedies. I have not looked over the prescriptions written in the United States for a year prior to the ratification of the amendment to the Constitution against alcohol. I feel certain, then, that if I could read every one of them I would not find beer prescribed for remedial purposes in a single one. Rated on the scale of usage, therefore, beer has not now and never has had any standing as a recognized remedial agent.

"Already application has been made to start breweries for making medicinal beer. If the ruling of the former Attorney General is carried into effect the profits of beer brewing in this country will rise to heights never known before. The vitality and morbidity statistics will be swelled by such a new multitude of sick and convalescent as to try the capacity of the printing presses of the Census Bureau. Convalescence will be a disease which will kill more people than consumption. Those who have the welfare of the medical and pharmaceutical profession at heart and who want to see an honest and efficient execution of the prohibition act will unite as one in the effort to secure a recall of this order by the present Attorney General of the United States. It was not a kindly act of Mr. Palmer to pass this buck to Mr. Daugherty."

The Hennepin Atomized Fuel Co., Minneapolis, Minn., will build a new one-story fuel-crushing plant at St. Paul, to cost about \$150,000, including machinery. C. L. Pillsbury, 1206 Second Avenue, Minneapolis, is engineer.

Food Value of Margarin

By J. S. Abbott

Secretary-Treasurer, Institute of Independent Margarin Manufacturers

THE importance of fat in the human dietary has been a matter of common knowledge for ages, but this fact was never greatly emphasized on a world scale until near the close of the war. The sources of the edible fats of different countries differ somewhat. Until recently the people of this country obtained their fats as fats almost inclusively from cattle, hogs and sheep in the form of butter, lard, and "drippings." Olive oil had been a common foodstuff for centuries in many countries of the old world. Coconut oil is eaten in large quantities in the tropical countries in which cocoanuts are grown. Cottonseed oil, peanut oil, corn oil and many other vegetable oils have recently become common articles of food in this country either as cooking fats or as salad oils. Margarin is a combination of edible fats made in the form of butter as a substitute for butter. It is used wherever and for whatever purpose butter is used. The following statements appear in Bulletin 469 of the U. S. Department of Agriculture:

"A discussion of animal fats would not be complete without some mention of oleomargarine, called "margarin" in Europe. The principal fats used in its manufacture in the United States are oleo oil, neutral lard (that is, a specially rendered lard), and cottonseed and other oils. All these ingredients must be pure and prepared with care in order that none of them shall have any marked taste or odor. These are mixed in such proportions as will give the final product a melting point very near that of butter. After being thoroughly mixed the fats are churned with a small quantity of milk and sometimes cream, the proportions of these used depending upon the quality of the product desired. In the preparation of high-grade oleomargarine varying quantities of butter are also added. The resulting product is then washed, salted, and worked as in ordinary butter-making processes. Oleomargarine is not used as extensively in this country as in Europe, where it serves both for table and culinary purposes."

The principal fats and oils used in the manufacture of margarin at the present time are oleo oil, "neutral," peanut oil, cottonseed oil and coconut oil.

The value of any fat or oil as food depends upon its digestibility, energy value, looks, taste, odor, and texture. In recent years fats and oils, as well as many other foodstuffs, have been found to contain certain food accessory substances, called fat-soluble vitamins, which play an important role in nutrition.

Digestibility

The digestibility of some of the common edible fats, according to bulletins 310 505, and 613 of the U. S. Department of Agriculture, is as follows:

	Per Cent		Per Cent
Margarin	97.55	Oleo oil.....	96.8
Butterfat	97	"Neutral"	97
Cocaoanut oil.....	97.9	Peanut oil.....	98.3
Cottonseed oil.....	97.8		

Energy Value

The value of a fat as a food is commonly estimated in terms of its energy value. This is expressed in calories. For the fats above, according to Bulletin 469 of the U. S. Department of Agriculture, they are as follows:

	Calories		Calories
1 lb. Margarin	= 3500	1 lb. Oleo oil	= 4080
1 lb. Butter	= 3490	1 lb. "Neutral"	= 4080
1 lb. Cocaoanut oil	= 4080	1 lb. Peanut oil	= 4080
1 lb. Cottonseed oil	= 4080		

It is clear, therefore, that margarin is the equal of butter in so far as their digestibilities and energy values are concerned. This fact was made known a long time ago by such famous nutrition experts as Luhrig, Barterelli, Hulbgren, Landergren, the Massachusetts State Board of Health, and Halliburton and Drummond.¹ Taylor very recently confirmed it.²

Taste, Odor, Looks and Texture

The taste, odor, looks and texture of foodstuffs are just as important food values as digestibility and energy. These properties, as they occur in high grades of butter, have been acceptable to consumers for centuries. Margarin manufacturers therefore have striven, and with great success, to incorporate the same properties into margarin. So successfully have they done so that it would take an expert taster to tell the difference between butter and margarin at the factories or as long as they have been properly kept. This can be believed when it is remembered that the chief difference in the composition of butter and margarin is that one contains milk fat and the other contains milk fat and animal or vegetable fats or a mixture of two or more of them. Fats have very little taste or flavor. On this point, Holmes and Lang³ make the following statement:

"The flavors and odors of fats are probably due to the presence in them of small amounts of difficultly removable substances rather than to specific properties of the pure fats themselves, in view of the fact that flavors and odors become much less noticeable the more completely the fats are purified. The characteristic flavor of butter, for example, is due to the absorption by the fat of the substances formed in the fermentation of milk and cream by lactic acid and bacteria and to the presence of small particles of the curd."

The flavor of margarin is likewise due to "the absorption by the fat of the substances formed in the fermentation of milk and cream by lactic acid and bacteria and to the presence of small particles of the curd." Each type of margarin made in this country is made by churning fats and oils in ripened milk or cream and gets its flavor from them. The color, odor, and texture likewise simulate those of good uncolored butter. When margarin is colored it looks like colored butter.

In consideration of the digestibility, energy value, taste, looks, color, and texture of good butter and margarin, it is apparent that the one may be substituted for the other as a table fat or as a culinary fat. In consideration of cleanliness and wholesomeness there are possibilities of wide differences. Nearly all of the margarin made in the United States is made under the constant supervision of Federal Government inspectors. There is no such supervision over the manufacture of butter.

Fat Soluble Vitamines

Just what foodstuffs contain appreciable quantities of the fat-soluble vitamins has been the subject of tedious investigations by nutrition experts for about 10 years. A compilation of all the work done on this problem was made and reported in July, 1919, by a

¹Halliburton and Drummond, *The Journal of Physiology*, September, 1917.

²Dr. A. E. Taylor, School of Medicine, University of Pennsylvania, *The Saturday Evening Post*, March 5, 1921.

³A. D. Holmes and H. L. Lang—*Bulletin 460*, U. S. Dept. of Agr.

committee appointed jointly by the Lister Institute of Preventive Medicine and the Medical Research Committee of National Health Insurance, England.⁴ This authority makes the following statement concerning the source and quantity of fat-soluble vitamins in our various foodstuffs:

"The primary sources of fat-soluble A are found in the green leaves of plants, and the embryos of certain seeds. The former appear to be the richer source, but very few quantitative data upon the distribution of the substance have yet been obtained. It is, therefore, difficult to attach a definite value to any individual foodstuff as a source of fat-soluble A. This is particularly true in the case of the foodstuffs of animal origin, as their value as sources of that factor is in all probability directly determined by the nature of the diet which the animal has previously received. Thus, the milk yielded by a cow which has for some time past been receiving a diet deficient in fat-soluble A will, without doubt, sooner or later show the same deficiency.

"The following tabulation of the chief foodstuffs has been made with the object of illustrating the distribution of the fat-soluble A factor.

TABLE OF FOODSTUFFS WHICH CONTAIN FAT-SOLUBLE VITAMINES

Butter	Cod-liver oil and other fish
Cream	liver oils
Margarin prepared from animal fats other than lard	Herring oil, salmon, or cod oil
Nut butter	Liver
Mutton and beef fat	Kidneys
Heart	Onions
Brain	Potatoes
Sweetbreads	"Fat" fish, as herring, salmon
Linseed	Fish roe
Linseed cake (after expulsion of oil)	Wheat embryo
Peas	Maize embryo
Kidney beans	Rice embryo and bran (i. e., so-called rice polishings)
Soy-beans	Wholemeal bread
Cabbage (fresh)	Millet
Cabbage (dried)	Bananas
Lettuce	Nuts (walnuts)
Spinach	Cheese (prepared from whole milk)
Carrots (fresh)	Eggs (yolk)
Carrots (dried)	Eggs (dried)

It will be noted in the table above that the Committee by inference stated that margarin made from lard does not contain the fat-soluble vitamin. Margarins are not made of lard in this country. It also stated that the vegetable oils are somewhat deficient in these vitamins. Since that time, however, the fat-soluble vitamin-content of animal and vegetable oils has been the subject of more careful investigations. Many of these fats and oils hitherto reported as deficient or entirely lacking in these bodies have been found to be rich in them. Daniels and Loughlin⁵ found that rats fed on a ration from which all fat-soluble A had been removed except what was in the lard of the ration "grew normally, reproduced, and reared their young." They got the same results with cottonseed oil. Both of these fats are used in the manufacture of margarins.

Just as lard and cottonseed oil have recently been found to contain quite a plenty of fat-soluble A to promote growth, reproduction and the rearing of the young of animals, just so it may be that all other fats and oils hitherto reported to be deficient in it are quite efficient in this respect. The same kind of fat or oil at different times and under varying circumstances may contain different quantities of fat-soluble vitamins. Osborne and Mendel have separated butter

fat into yellow fat rich in fat-soluble A and into white fat which is deficient in it.⁶ It is not present in some grades of butter. Steenbock⁷ says the vitamin-content of butter varies with the breed and feed of the cow. He reported one experiment in which the butter fat of a cow fed exclusively on alfalfa hay did not contain any fat-soluble vitamins.⁸ He also has found that butter rich in natural color (not the color added to it by the creamerymen) is also rich in fat-soluble vitamins.⁹ White butter to which creamerymen add color is generally if not always poor in this respect.

Only a very few researches have been carried on to determine the fat-soluble vitamin content of margarins. The milk and cream and the fats and oils used in the manufacture of margarin contain these vitamins.^{11, 12, 4, 5} The processes of the manufacture of margarin do not affect them. Some margarins are quite able to replace butter in satisfying our nutritive requirements.^{1, 11} All other margarins have appreciable quantities of fat-soluble vitamins.

From the foregoing facts, it is clear that there is not any essential difference between butter and margarin with respect to these food accessory substances. Butter and margarin are as much alike in digestibility, energy value, taste, looks, texture, odor, and vitamins as it is possible for two products to be alike and not be the same thing.

In view of the foregoing facts, it is not at all strange that Katherine Blunt¹⁰ in her closing remarks on the Present Status of Vitamins made the following comment:

"It is difficult to say what is the importance to the average individual of giving thought to these three vitamins in choosing the diet."

⁴Osborne and Mendel—*Journal of Biol. Chemistry*, Vol. 40, p. 379.

⁵Steenbock, H., Laboratory of Agricultural Chemistry, University of Wisconsin—*The Science Press*, Vol. 50, p. 352.

⁶*Journal of Biological Chemistry*, September, 1918.

⁷Steenbock and Boutwell—*Journal of Biol. Chemistry*, Vol. 41, p. 81.

⁸Katherine Blunt and Chi Che Wang, University of Chicago—*The Journal of Home Economics*, Vol. 12, No. 1.

⁹*Proceedings of the Physiological Society*, London, January 27, 1917, p. VIII.

¹²E. V. McCollum—*Journal of Home Economics*, May, 1917.

Hinde & Dauch Paper Co., Sandusky, Ohio, manufacturers of board and corrugated paper products, will build a new plant at Fort Madison, Iowa, to cost about \$1,000,000, plans for which are being prepared by the Ferguson Co., Columbus, Ohio.

The department of chemistry, University of Wisconsin, Madison, Wis., will conduct during the summer session a course in the manufacture of organic chemicals under Prof. Glenn S. Skinner, designed to supply the research needs of the various scientific departments of the University. Only eight advanced students will be admitted to the course, and they will work from nine to ten hours a day and will receive about 40 cents an hour for their work. Only the most promising graduates and upper class men will be selected for the work, with the view to giving them intensive training in practical organic chemistry and experience in larger scale operations. Prof. J. H. Matthews, director of the department of chemistry, says that most of the chemicals now available for experimental work are obtained only at excessively high prices, and the department is compelled to make the choice between excessively high laboratory fees and curtailment of laboratory instruction. It will be possible, with the laboratory facilities available during the summer months, to manufacture these chemicals more cheaply than they can be purchased, thus materially cheapening the cost to the student.

¹¹Report on the Present State of Knowledge concerning Accessory Food Factors (Vitamins), Medical Research Committee, National Health Insurance, Special Report Series No. 38, London, July, 1919.

¹²Amy L. Daniels and Rosemary Loughlin, Dept. of Nutrition, Child Welfare Research Station, Univ. of Iowa, Iowa City—*Journal of Biological Chemistry*, Vol. 42, No. 3.

American Institute of Chemistry

Additional Observations on the Project of an Economic Organization of Chemists

NO subject has been submitted to the personnel of the chemical industries that has aroused the interest of chemically educated men so much as the project originating with the New Jersey Chemical Society to coalesce into an active, helpful, stimulating organization the material interests of chemists. The reason is that the time is ripe and becoming increasingly so for organized consideration of the chemists' relation to industry and the impact of both upon the State.

The appreciation by the people of the utilitarian aspects of technical education; the growing accession of chemically educated men to the ranks of industry; their usefulness demonstrated in a time of great national emergency; their specialization in the work of production; the encouragement of emulation that the ones with ability to boss more quickly may come to the top; their increasing utilization in positions of administrative responsibility and the recognition of the fact that not remote is the day when every industry involving the transformation of matter will be dominated by chemically trained men, emphasize the need of an organization of American chemical ability in every department of chemical industry to function in terms of service to industry, in contradistinction to a supercilious segregation of highly specialized and variant ability always dominated by men of the same breed but of broader grasp of the implements of industry.

The many who appreciate the place of such an organization in the activities of ambitious men identified with chemical manufacture and merchandising have little patience with the well-intentioned expressions of those who seek to define, set off and aggrandize an important but a particular and a shifting group.

Aside from the value of such expressions as intellectual exercise, they disclose the characteristics of chemically trained men engrossed with details which, however basic and essential they may be, are but an elementary part of the plans of the general staff to conduct a chemical industry for the purpose of making money.

The energy displayed in the discussion of class glorification and of the procedure of eliminating those who do not measure up to standards of the self-elect reminds one of the old school-men whose arguments as to how many figures could do the medieval shimmy on the point of a needle are one of the curiosities of history.

Any organization today not grounded in the principle of helpfulness to others has little excuse for existence; the tide is flowing against group aggrandizement. Furthermore any proposed organization that seeks to duplicate the machinery of service already in existence is similarly conditioned. Kindly permit us to emphasize the anomaly of educated men consecrated to increased production and efficiency in the great basic industry, nursing the idea that they can monopolize favor and get away with it. Broad-minded as many of us are, there are too many who do not realize that they can grow and prosper only to the degree that they share their favor.

The interest of chemically educated men in this subject is an expression of the decentralizing tendency in the organization of segregated workers. The form of organization adapts itself to the service to be per-

formed. To cultivate bureaucratic centralization with conspicuous jobs for the few who constitute the operating engineers of the machine, not only represents a natural process gone to seed and a sacrifice of usefulness to the masses who support it, but invites disintegration which grows as the masses appreciate the neglect of their essential interests.

However desirable many aspects of centralization may be, the disposition to monopolize the intellectual enterprise of great groups of professional workers becomes repugnant to a degree that often may be characterized as an abuse. So varied become its interests and attempted functions that neither one or the other are cultivated or performed in any measure approaching general satisfaction, to say nothing of studied neglect of avenues of usefulness which represent the penetration of practical helpfulness into the ranks of men in the industry and upon which efficiency and progress are predicated.

It is here that we touch the desire and voice the aspiration of the men who organized the New Jersey Chemical Society and out of which grew the suggestion of an economic organization of chemists which would be not primarily a paper-reading society, or a mutual admiration organization, or the seed-bed of an aristocracy of chemical politicians, but an organization to study the material needs of educated chemical workers and the service of the industry. Its subject would be men and not material alone and its environment every element concerned with their creation and utilization in the work of production.

Just as industrial progress is an expression of individual development, so the welfare of the man is inseparable from what he makes and sells. What was conceived is an industrial organization and not a scientific society, for their respective service is separate and distinct.

The business of making a living, of making a home, of giving one's children as good a start as he himself got, of cultivating the proficiency and meeting the opportunity that make all else possible, are personal problems too important in a competitive system to warrant their further neglect by any organized body of chemists; and these can be solved most effectively only as they are considered in connection with the demands of the industry upon the man, and of the man's reaction and of the service of both to society.

A college degree is not a label of superiority but a badge of responsibility. What more inspiring task could be set to broad-minded educated workers in the chemical industry than to enlist the service of the teaching chemist, the production chemist and the business chemist to study chemical production, distribution and consumption in terms of the human element whereby men could be utilized most efficiently, goods produced most cheaply and the people served best?

Don't let us clutter up our minds with inconsistencies and impracticalities, or magnify the inconsequential, or be consumed with pre-conceived ideas, but lay ourselves to the job of how to utilize best for the progress of the chemical industry and hence for ourselves whatever advantage we may have.

The trouble with many of us is that we have over-trained intellectually; that we don't know how to use to the best material advantage what we know; that we are deficient in salesmanship; that too much time is

wasted in futile adjustment of square pegs to round holes.

Industrial chemists need an industrial organization that will teach them their deficiencies that they may be corrected while correction is most helpful, and provide an outlet for service upon which growth in the last analysis only is based.

The project needs only leadership to become the most effective and inspiring human agency in the chemical industry.

Is it not a commentary on the conventional characteristics of the chemist that after having got hold of the tail of a big idea no one apparently has the courage to swing it?

New Jersey Chemical Society

AT the March meeting of the New Jersey Chemical Society held at Stetter's Hall, Newark, N. J., on March 14, a large attendance heard the address by Dr. E. Newton Harvey, Professor of Physiology at Princeton University, on the production of light by animals.

Dr. Harvey outlined the various groups of vegetables and animals which are known to possess luminescence and said that the two questions most frequently asked him, namely, whether there was any phosphorus involved in the reactions and whether the animal light would ever become commercialized, could be answered both in the negative. Phosphorus as such certainly was not present and the amount of light given off by even the most brilliant of these creatures was insignificant in terms of standard candle power.

Dr. Harvey pointed out that there were three elements involved, viz., a substance which had been named Luciferin, a catalytic agent which had been called Luciferase and Oxygen. These three had to co-operate to produce the light, and in so doing the Luciferin undoubtedly was oxidized. It could again be reduced and again be oxidized.

Dr. Harvey said that there was one reaction known in organic chemistry which was analogous and that was the oxygenation of an extremely dilute solution of pyrogallol by hydrogen peroxide in the presence of a vegetable juice, such as that derived from potatoes; this latter took the place of the Luciferase.

Dr. Charles Baskerville, Professor of Chemistry at the College of the City of New York, spoke of his researches on anaesthesia in co-operation with the well-known anesthetist, J. T. Gwathmey.

The report of the Nominating Committee was read and Dr. R. G. Wright of Rutgers College was elected president of the society for the ensuing year.

Report of the committee on the proposed American Institute of Chemistry was read and approved. The result of the initial investigation of the project of an economic organization of chemists showed an overwhelming opinion in favor of its establishment which insofar as the New Jersey Chemical Society is concerned should not be by a separate organization but by the inclusion of such functions of the proposed organization as are not already exercised by the society. The proposed organization accordingly practically is established for the state of New Jersey from which center of the chemical industry it is expected to spread as its virtues warrant. The report of the committee on the proposed institute follows:

To the Members of the N. J. Chemical Society:—Your committee prepared a tentative scheme and gave it fairly wide publicity, sending it to the journals and prominent chemists and discussing the matter with many. From the printed and written comments and conversations it appears there are three groups of opinions:

1. That an American Institute of Chemistry is not needed.

2. That an Institute of Chemistry should exist as an adjunct to or function of the American Chemical Society. No one holding this view points out how the American Chemical Society could so function. We are advised to bring the matter to the attention of the officers and council, as was done about fifteen years ago.

3. That an Institute of Chemistry, to function, in general, as outlined, is needed; that it should be started by the New Jersey Chemical Society, beginning in New Jersey and showing by experience its advantages and developing working plans adapted to the entire country.

Your committee recommends:

A. Anything done should be handled by the New Jersey Chemical Society and not by a new organization.

B. That in view of the fact that even the simplest listing, etc., will require time and money, the entire matter be referred to the Board of Governors for further action.

The committee extends to all who have answered its questions their hearty thanks for the interest taken in the matter.

GEORGE T. COTTLE.
C. P. TITUS.
F. D. CRANE, Chairman.

Hardened Copper Not a Lost Art

There is nothing new or mysterious about hardened copper, says the Bureau of Standards. It is not one of the lost arts; immense quantities are in commercial use and added uses for it are being found every day. There are two well-known methods of hardening copper; the first being by means of mechanical working, while the second is to alloy it with a certain amount of another metal and in some cases with more than one metal. As examples of the first kind of hardened copper, we may consider hard drawn copper wire and cold drawn tubing. The wire used for trolley systems is a good example of one of these classes.

Copper hardened by the second method is not usually referred to as copper but as brass and bronze. Many persons apparently ignorant of the fact that hardened copper is in use every day have so manipulated the melting of copper in their experiments that the resulting melt is impregnated with oxide. Cuprous oxide is soluble in molten copper and alloys with it in exactly the same sense as the metals mentioned above. Copper treated in this way is considerably harder than the pure metal but is unsuited for most commercial purposes.

E. I. du Pont de Nemours & Co., Wilmington, Del., announce plans for the construction of the world's largest dry color plant, probably in proximity to the site of its main plant at Carney's Point, across the Delaware from Wilmington. Expansion in this department of the company's business will embrace an addition to its lithopone production facilities.

Influence of a Synthetic Dye Industry Upon Our National Welfare

By Marston Taylor Bogert, A.B., Ph.B., LL.D.

Professor of Organic Chemistry, Columbia University

COULD the public see clearly the bearing of a well developed and diversified synthetic dye industry upon our individual and national welfare and how vital it is to our progress and prosperity, legislation long ago would have been enacted to protect and stimulate our domestic effort in this field and to safeguard it against threatened overwhelming by foreign dumping and competition*

To those who would raise the bogey of an American dye trust, I would reply that there is ample room in our country for small as well as large manufacturing units in this industry, as in the steel business for example. The existence of the U. S. Steel Corporation has not put the independent operators out of business, nor been to the disadvantage of the community.

German Industrial Solidarity

In world commerce, as in a world war, there is but one rational method of attack, and that is with an organization of a size and power commensurate with the undertaking. To attempt otherwise, will be as futile and as disastrous as were the efforts of the allies to fight the German war machine with a number of separate and insufficiently co-ordinated armies. The greatest and most powerful of Germany's industrial combinations is her giant dye combination. This huge consolidation has already called for additional capital, the life of the trust has been extended from the year 1966 to 2000, and its dissolution made more difficult by requiring a four-fifths, instead of a two-thirds, majority vote of the participating firms to unscramble it.

Further, the Haber nitrogen fixation industry, with an authorized capitalization of half a billion marks, has been placed under the jurisdiction of this same dye trust. Control of the nitrogen supply means direct control of all explosives and of one of the most important constituents of all fertilizers, as well as indirect domination of many other industries. To compete in the world's markets with this giant organization, with the largest and finest equipment in the world as the result of 40 years of intensive effort by thousands of eminent chemists and engineers, certain of our legislators appear to advocate a policy which will make it impossible for us to form any combination equal to the struggle.

We have far less to fear from any American combination, the regulation of which is after all in our own hands, than from foreign domination of our industries, a control which Germany is now seeking to acquire and toward which goal she is driving with characteristic thoroughness, persistence and concentration. Our grave danger lies in our failure to apprehend the deadly character of this menace to our safety and in the short-sighted opposition of those textile manufacturers who cannot see that it is to their own self advantage to foster and encourage an American dye industry. If Germany once gains the upper hand in this key industry, we shall ultimately become a subject nation for, as Lincoln said, "no nation can long exist half slave and half free."

Natural Dyestuffs

Chemistry has not only determined the actual tinctorial constituents in many natural dyes and reproduced them artificially, but it has also shown the way to prepare tens of thousands of other dyes which, so far as we are aware, are not found in nature. Compared with the industry of the artificial dyes, that of the natural dyes is today relatively insignificant. The chemist has succeeded in producing artificial dyes of every conceivable shade of the rainbow, at such a low price, of such purity, fastness and beauty, that the natural dyes either have been driven from the market, or the best of them (like alizarin and indigo) are now made synthetically. Logwood is the most important exception to this, although small amounts of gambier, turmeric, orchil, persian berry extract, saffron, madder and other natural dyes imported in the year 1919 was \$1,247,188, while the artificial dyes and color lakes made in this country the same year were valued at \$71,778,819.

Synthetic Dyestuffs

According to the recent census conducted by the U. S. Tariff Commission for the year 1919, there were 214 manufacturers of dyes and intermediates; 116 concerns engaged in the manufacture of intermediates; and 155 in the production of finished dyes and other synthetics, 90 of them turning out only dyes (63,402,194 pounds, valued at \$67,598,855).

Those engaged in other lines than dyes were as follows:

Number of firms	Goods Made	Pounds	Value
34	Color lakes	7,569,921	\$4,179,964
31	Medicinals	6,777,988	7,883,071
10	Photochemicals	335,509	1,059,340
9	Flavors	610,825	1,318,654
6	Phenolic resins (5)		
	tannins (1)	3,794,534	2,381,358
6	Perfumes	41,419	164,302

Considerable progress was recorded in the United States dye industry during 1919. The list of intermediates was augmented by 76 not previously manufactured here, bringing our total up to 216, and there was a considerable increase in the output of the higher grade ones. In the quality and quantity of finished dyes, there was also a gratifying growth as compared with 1918, the total production being 38 per cent. greater in amount than our total imports of dyes for the fiscal year 1914.

In fact, we have ourselves already become exporters of dyes, our exports for the nine months ending September 30, 1920, having been valued at \$26,032,389, which exceeds the total value of dyes imported during the fiscal year 1914. Of this amount \$17,038,235 represented aniline dyes, \$2,321,090 logwood extracts, and \$6,673,064 other dyes. To be sure, an important factor in this achievement was the absence of foreign, especially German, competition, but it shows none the less the rapid strides made in the development of our domestic industry.

Our 216 intermediates in 1919 were derived from the following crudes: benzole, 55; toluene, 47; xylene, 4; naphthalene, 66; anthracene, 10; carboic acid, 26; other crudes, 8.

*Abstract of address delivered before the Franklin Institute, Philadelphia, Pa., February 16, 1921.

Influence of Dyestuffs Industry Upon Advancement of Chemistry

The influence of the synthetic dye industry upon the advancement of the science of chemistry has been deep and far-reaching. For the solution of many of the problems arising in the plant, experts in all branches of chemistry must be enlisted, and the results of this concentrated and intensive investigation have led not only to the solution of the particular problem immediately in hand, but of many collateral problems as well, inorganic as well as organic, and not infrequently to the uncovering of new laws of fundamental significance to the entire science.

Great industrial research laboratories have been established and organized by the manufacturers, manned by able investigators and, in Germany for example, the university laboratories have often been called into active co-operation, thus adding the knowledge and experience of the university professor to that of the technical staffs of the plants on the one hand and, on the other, vitalizing the university teaching by bringing the teacher into actual personal contact with the applications of his lectures and keeping his information more nearly up to date.

It is a pleasure to record that this co-operation has also taken the form of endowments in several instances, providing much needed financial assistance for our educational institutions, and giving to deserving students an opportunity otherwise unattainable of gaining advanced training and thus becoming more useful citizens.

The Organic Chemist

For the highly trained synthetic organic chemist, the dye industry with its collateral and related industries makes the greatest demand. As the manufacture of explosives and of chemical warfare munitions is likewise mainly dependent upon men with similar education and experience, and much of the equipment and many of the operations are alike in all three lines of activity, it will be readily understood why a modern synthetic dye plant is referred to as "a potential arsenal." Germany's great dye plants were converted almost over night into real arsenals for the manufacture of munitions.

Badly handicapped as we were in the matter of dye plants when we entered the war, our most serious deficiency was the lack of a sufficient number of skilled organic chemists to man new plants when these were ready. Under the stress of war conditions, a factory may be erected and equipped in six months, but it takes six years' education after high school to fit a man to begin learning the practical operations involved in large-scale production, and many months of such experience before he can really handle his job efficiently. It may be that a million men "will spring to arms over night," but the crop of chemists grows more slowly.

Following the armistice, large numbers of young men entered our universities filled with enthusiasm over the prospects of developing in our country a great dye industry, and eager to prepare themselves for a worthy part in that expected development. The attitude of Congress, in holding up for nearly two years the legislation necessary to protect and encourage this business, has chilled the enthusiasm of these students, and many are either in serious doubt as to the wisdom of embarking upon such a career, or have already switched to something else.

A continuance of this attitude on the part of the Congress will result in an immediate and considerable reduction in the number of young men selecting organic

chemistry as a profession, and should our country be forced into war in the near future, she will once more be wholly unprepared through absence of the experts necessary to increase her output of munitions, and the lack of officers for the industrial army is fully as serious as for the military army.

Of the 214 concerns engaged in the manufacture of dyes or intermediates in the calendar year, 1919, 65 maintained separate research laboratories for the investigation of problems arising in the works and for the discovery of new substances or improved processes. The amount of money spent on these laboratories that year for salaries, apparatus and supplies, deducting the saleable products turned out by them, but without figuring any overhead or all the cost of translating test-tube results into successful large-scale operation, was \$4,274,247.

What the Loss of This Industry Means

Let us understand fully what the curtailment or abandonment of this industry is likely to involve, for it is not so much the amount of money involved, although that is considerable, as it is the bearing upon our life as a nation that counts. Its immediate consequences, some of which are making their appearance even now, may be recapitulated briefly as follows:

1. Thousands of unskilled laborers thrown out of employment.

2. Large numbers of specially trained technical experts forced to seek other means of livelihood, and the economic loss involved in scrapping the experience gained in the dye industry.

3. Abandonment by the manufacturers of all plans for development and expansion, and the closing of plants now in operation.

4. Fewer students for the courses in chemistry at our educational institutions.

5. Termination or reduction of research work, both in the laboratories of the industry and in co-operative investigations with educational institutions, with all that this implies in retardation of the development of our science at a time when the world is looking to us to take the leadership.

6. Inability of teachers of applied organic chemistry to give their students up-to-date information in the field of synthetic dyes, through loss of personal contact with the manufacturer, and an inevitable resulting dependence upon the ancient history of the average textbook of industrial chemistry.

7. Subjugation of our great textile industry and of other industries using dyes or dye intermediates by foreign manufacturers, and in the event of our being cut off from such supplies by another war, once again to be face to face with a famine, not only in the dyes needed for our flags, uniforms, and other articles, and the bacteriological stains for the diagnosis of disease, but in many indispensable drugs and in compounds of serious concern to the manufacturers of photographic chemicals, food preservatives, explosives, toxic gases and other war munitions, paints, inks, perfumes and flavoring principles, artificial resins, plastics, tannins, and accelerators for rubber vulcanization; the distilling of coal tar and the recovery of by-products from the coking of coal will also suffer from the loss of this market for their products.

8. Should we be one of the belligerents, there will be but few dye plants available for conversion to munition manufacturing, be it explosives, toxic gases, smokes, incendiaries, or what not, and no reserve of trained men to take charge of such operations. It is trite, but true,

that modern military power is dependent upon industrial organization and efficiency.

9. Domination of our trade in dyes and dye intermediates, by Germany for example, is quite certain to lead to the control of others of our industries as well, until the penetration of our industrial fibre will resemble that of the chestnut tree by the deadly fungus which has so nearly obliterated these beautiful trees from our groves.

10. The world markets open to other nations will be inaccessible to us.

It is no exaggeration to say that the life of the state, as of the individual, some day may be decided by the existence or non-existence here of a well-developed, expanding and progressive synthetic dye industry, and if this hasty and very imperfect presentation of the subject has helped to give you any better appreciation of its significance to all of us, I shall feel well repaid.

Chemical Disarmament

As chemical warfare was responsible for nearly a third of all our casualties in the war, and as this proportion is quite certain to be higher in future conflicts, it is idle to talk about disarmament without including the munition plants represented by Germany's great dye industry and nitrogen-fixation units. Because of the role which these play in the economic life of the nation at peace, they cannot be destroyed without destroying Germany as well.

Where disarmament is impossible, there is but one answer—counterbalancing armament. Hence, the one sane and practicable disarmament which we can really accomplish is an offsetting equivalent or superior development of our own dye and air-nitrogen industries. It is the most effective guarantee of peace, and in the long run much the cheapest form of insurance.

Conclusion

The important question is "Do you want the synthetic dye industry to remain and develop in this country, or not?" If you do not, or are wholly indifferent, take no action whatever. The German propaganda and its friends will do the rest for you. But if you are convinced that this industry is linked in so vital and intimate a manner with the welfare of our citizens and the safety of our state that it is essential to the maintenance of our proud position among the nations of the world, you will do what you can to see to it that such legislation is promptly enacted as will provide adequate protection while the industry is still adolescent and vulnerable, and will immediately wire your senators and representatives in the Congress urging such action upon them, for "Where there is no vision, the people perish."

The Celluloid Zapon Co., 200 Fifth avenue, New York, has opened a branch office at 520 Walnut street, Philadelphia, Pa., for the distribution of its nitro-cellulose products. The use of these materials as lacquers, enamels, varnish and for textile impregnation in the manufacture of substitutes for leather, is one of the many notable achievements of applied chemistry. Modern lacquer manufacture dates from 1886 when Richard Hale and his son-in-law, Frederick Crane, began the manufacture of pyroxylin lacquers at Springfield, N. J., which enterprise was the inception of the Celluloid Zapon Co.

* * *

The Grasselli Chemical Co. reports its net earnings for the year ended December 31, 1920, after allowance for depreciation and all taxes, as \$3,181,441, compared with \$3,972,297 in 1919 and \$4,000,018 in 1918.

American Oil Chemists' Society

The expansion of the vegetable oil industry in America can be attributed largely to the disturbed economic conditions of the war whereby the inadequacy of animal sources of glyceride supplies compelled recourse to every available vegetable source, with the result that the American vegetable oil industry no longer is based on a by-product of the cotton fibre but now draws upon world resources for its raw materials of crude vegetable oils of various kinds.

This expansion is illustrated, from the standpoint of technical control and research in the industry, by the transformation of the Society of Cotton Products Analysts into the American Oil Chemists' Society. The limitations of the former organization is indicated by its title; the new name shows the embracing character of the present interests of this organization. Moreover, it indicates the decentralizing tendency in the organized interests of industrial chemists. Specialization of industrial service demands similar specialization on the part of those who control its processes and determine its production efficiency, if the maximum benefit of such organization is to be attained.

The organizations of fertilizers, food, leather and paper chemists, for example, also illustrate this decentralization and the desire to connect technical interests more directly with the industrial problems of their respective fields.

Its active membership embraces not only all persons engaged in chemical work relating to fats, oils, waxes and allied interests provided they have had at least five years' chemical training, but others similarly qualified who are engaged in the various industries consuming vegetable oils. Its present officers are: President, F. B. Porter, Fort Worth Laboratories, Fort Worth, Texas; vice-president, C. B. Cluff, American Cotton Oil Co., New York City; secretary-treasurer, Thos. B. Caldwell, Law & Co., Atlanta, Ga.

The 1921 annual meeting of the society will be held in Chicago at the Congress Hotel on May 16-17, preceding the annual meeting of the Interstate Cotton Seed Crushers' Association, May 18-20.

Color Standardization

The Textile Color Card Association, Inc., 315 Fourth avenue, New York, has issued under the above title a booklet descriptive of the purposes of this trade organization and the progress made since its establishment in 1915.

Its membership embraces prominent concerns engaged in the manufacture and application of dyes. Its purpose in the standardization of color is not the suppression of individuality in color development or the expression of a standardized monotony in the use of dyestuffs but the establishment of a guide to the practical use of colors in all the industries. This it does by the distribution in every field wherein commercial value is influenced by the application of dyestuffs, the Standard Color Card and Season Color Card. Their use not only simplifies color work but serves as a handbook for every industry in which dyestuffs are essential.

The Armour Fertilizer Co. has just completed the addition of a sulphuric acid plant costing \$250,000 to its fertilizer works at Greensboro, N. C.

The American Trona Corporation, New York office Woolworth Building, identified with American enterprise in the development of potash resources at Searles Lake, Calif., has added borax in its various grades to its list of products.

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A Consolidation of
The Chemical Engineer
and Chemical Age



THE regret accompanying the unsatisfactory ending of the London conference for the settlement of the German reparation has stiffened into determination that the victor shall not likewise be the victim but that the unscrupulous disturber of the world's peace shall repair to the measure of his present and future ability a part of the damage done.

Germany shall not capitalize the world's dependence upon her resumption of her part in its work as a condition precedent to its recovery, to escape the payment of a reparation whose great inadequacy makes impossible the connotation of revenge.

Duplicity and dishonesty inculcated by its leaders in a nation of 60 millions of people schooled to thrift and production and with a national plant unmatched for efficiency, in a vain effort to escape the judgment of God, is the outstanding anomaly of the Christian Era.

THE collection of judgments of this character, however, are left to time and the law of retribution.

But the exigencies of men, if stability in human relations is to be maintained, demand such settlement as practical conditions will support.

However bitter may be the hearts of those who felt the Hun's heel grind the hardest, the world's welfare demands a magnanimity that many cannot see, aside from the fact that it is compelled by the impossibility of collecting more than the culprit can be induced to pay through labor, trade and taxation.

VALUABLE as it may be as propaganda for the enactment of legislation to protect the domestic dye industry, we deplore the emotional appeal of the denizens of the chemical lunatic fringe to disarm Germany chemically by the destruction of her dye plants because of the ease with which a peaceful process can be turned into a tool of war.

Such advice does not represent the sober opinion of American chemists, however keenly they may feel the

necessity of present protection of practically four years' experience against the Germans' forty.

Broad-minded American chemists today see nothing constructive in hatred and condemn its cultivation at a time when the appeal to reason provides ample exercise.

HENRY HOWARD'S discussion of the desirability of domestic over foreign valuation of imported goods not only discloses lax and discriminatory practices in past tariff administration, but effectually disposes of the problem of the difficulty and impossibility under present disturbed conditions of determining foreign production costs.

Domestic valuation of imported chemicals and all other goods subjects all entrants in the race for domestic business to the same handicap; it requires no investigation of foreign production conditions; its uniformity adapts it to an impost whether for protection or for revenue on a specific or ad valorem basis, and would introduce for the first in the protection tariff system an impartiality among foreign manufacturers seeking a place in the American market.

The possible abandonment of the licensing feature, already in force in Great Britain as a protection to the English dye industry, adds importance to the subject of domestic valuation of foreign dyestuffs in the early appeal of dyestuff producers for a satisfactory tariff as a substitute, should licensing not be granted.

THE precedent of Great Britain in enacting a licensing law for the encouragement of her immature dyestuffs industry, in the abolition of the excess profits tax and in the active consideration for early enactment of anti-dumping legislation, should be an incentive to similar prompt action by our new Congress.

The fact that our dyestuffs industry, thanks to the embargo of the war and American chemical enterprise, is the thriftiest outside of Germany, should not deprive it of the co-operation of the chief consumers of its products. Their selfish fears played little part in England's primary consideration of her national welfare.

The potentialities of the dyestuffs industry as a weapon of national defense warrant the co-operation of special interests, particularly when the procedure would work no injury to them, but would compel enterprise to serve them on the part of the beneficiary, to the end that German experience may have a formidable competitor in the world's markets and that the latest inhumanity may have opportunity to assume its highest efficiency in the discouragement of war.

IMPROVEMENT in domestic business awaits not alone the diffusion of deflation.

Mr. Raskob's emphasis of the necessity of financial co-operation with foreign buyers of American products is based upon sound English precedent and directs attention to the chief source of our economic ills.

Our surplus production must have markets in which

to needs must be joined ability to pay. Economic exhaustion finds this co-relation absent. New markets developed by us can be retained only to the degree that we match competition in credit, which under present circumstances must take the form of substantial interest in foreign consuming enterprises.

Such contribution to the restoration of foreign production which consumes our surplus serves there to galvanize latent buying power, makes possible the maximum operation of our own plants and maintains the buying power of our own market by the employment of our own people.

INTERNATIONAL interdependence more than ever before in history makes the world a trading unit.

Compulsory becomes its economic integration if national obligations are to be fulfilled in that exchange of service that supports the peace and progress of man.

Prudence sets a limit to aggrandizement of function that peoples everywhere may have the opportunity of growth.

EVERY obstacle in any country to wholesome world tendencies works to the disadvantage of that country in any service affected by that tendency.

Deflation in production costs is a world process and represents adjustment to the purchasing power of the buyer from which flows the beneficence of work.

The human element can resist this tendency only at the price of continued unemployment; for goods refuse to move at a cost level embracing a wage-rate out of line with all other elements.

Organized obstinacy to a natural tendency not only defeats its own ends but in the process denies to others the salvation of employment.

WITH ill-adjustment at home of the relations upon which buying power is based, and with slow resumption of unsupported buying power abroad, which in itself determines domestic prosperity, and with the lack of wide-spread recognition of the basic principles of trade, it is highly prudent to go slow with any political plan designed to protect American industry, which not only would curb it, but would complicate the settlement of issues of greater moment to American welfare.

Let us stew in our inconsistencies and contradictions until there is precipitated the conviction that one nation cannot dominate the service of the world and that the maximum benefit flows with the free interchange of goods to the end that surpluses may be absorbed and the law of supply and demand operate unvexed. More is to be gained along this line than from any legislative nostrum.

The favor due to war-born industries essential to national preservation and the correction of inequalities of wage rate and exchange should constitute the only exception to the free flow of the great staple raw materials and foodstuffs.

THE overwhelming approval of the project of the New Jersey Chemical Society to form an economic organization of chemists and the incorporation of its functions in the service of that society immediately establishes the organization in so far as relates to the State of New Jersey.

Inasmuch as the American Chemical Society 15 years ago repelled the proposal that it perform the utilitarian objects which would be the special province of this organization, it is unlikely at the present time to add to its catalogue of bureaucratic functions a responsibility from which it has always shied.

It was the object of the "founding fathers" of the American Chemical Society to consolidate and co-ordinate into one organization the diverse and many activities of American chemists, inasmuch as they were part and parcel of the great plan of chemical advancement for which the parent society would be its mouthpiece and prophet.

While no anti-trust act could be invoked to check the realization of this laudable purpose, natural law, while by no means a disintegrating influence as regards membership, expressed itself in the formation of satellites demanded by increasing specialization of industrial interest.

With growth has come the unwieldiness of bulk and its natural resolution into loosely articulated parts liable at any time under the impulse of efficiency to sever organic connection.

Consideration of the human problems of its members which demand intimate contact with diverse and distant environments and familiarity with their respective stimuli found little place in a highly centralized government of a scientific society.

Incompatible, hence neglected and ignored, are economic problems affecting the individual and the industry with the functions of a scientific society of catholic membership and monopolistic motives.

THE American Institute of Chemistry is not entirely an analogue of the competition that lurks in the shadow of monopoly. It shall seek under its own auspices to provide a needed service, the performance of which found little sympathy in an organization constitutionally indifferent to the material interests of its members.

The American Institute of Chemistry is an expression of the aspiration that among engineers found form in the American Association of Engineers whose growth and attainments are notable in the organization of technical men and whose functions closely approach those that the Institute shall seek to perform.

The extension of the service of the American Institute of Chemistry from New Jersey to other states and its recognition as a national organization will depend solely upon the alertness of American chemists to appreciate that the cultivation of the material is fundamental to the efflorescence of all that makes life worthwhile.

United Filters Corporation

The importance of filtration in chemical manufacture is illustrated by the expansion of the manufacturing facilities of United Filters Corporation which four years ago made merely a filter leaf on the second floor of a small building in Jersey City.

Its acquisition of the former plant of the Benjamin Iron & Steel Co. at Hazleton, Pa., provides ample room not only for present production but for the expansion inevitable with the growth of the chemical and allied industries.

The Hazleton property when taken over several months ago included a modern and thoroughly equipped foundry and a large machine shop building located on a 12-acre tract and served by connections of the Lehigh Valley Railroad, supplemented by the service of the Pennsylvania railroad, thus facilitating domestic and export shipments.

Additional construction during the past five months includes a modern office building, a machine shop with approximately 25,000 square feet of floor space and an up-to-date foundry with a capacity of twenty-five tons of grey iron castings per day.



HAZLETON, PA., PLANT OF UNITED FILTERS CORPORATION.

Since the first of the year the company has transferred all of its manufacturing facilities from Belleville, New Jersey. A quantity of new machinery has been added to the shop which is provided with modern tools for handling both small and large work. Even the largest of the Sweetland units weighing over ten tons are handled as readily as the laboratory units weighing less than a hundred and fifty pounds. The filter press plates and frames are machined on modern highly developed equipment that reduces the labor cost and insures the trueness of the parallel finished surfaces. The new plant at Hazleton is now busily engaged in manufacturing United Filter presses and Sweetland filters. The manufacture of American Continuous filters also will be started shortly.

The demand for its equipment in the cane and beet sugar districts; in the manufacture of maltose, cereal beverages, soft drihks, oil products; and in the chemical, mining and metallurgical industries, is responsible for the corporation's move to concentrate all of its manufacturing at one point. The main office and testing laboratory of the company have been transferred to Hazleton. The company still maintains sales offices in New York, Chicago and Salt Lake City with additional representatives in San Francisco, Los Angeles and Europe.

Dr. F. W. Hilscher, Robert Kellar and M. H. Eggleston of Spokane, Wash., have organized the Hilscher Food Products Co., capital \$100,000, to manufacture 3-minute soups, a dehydrated product developed by Dr. Hilscher.

How the Insurance Agent Views Present Conditions in the Methanol Industry

The slackness and uncertainty in the methanol market, with present prices around \$1.00 per gallon against the pre-war figure of 45 cents and practical cessation of production, lend interest to the insurance agent's view of the present situation as regards production. An agent reporting the results of his investigation in Pennsylvania and western New York, from the standpoint of fire hazards, says:

"There is no denying the fact that the alcohol business is entirely absent and has been so since early last fall. One reason for this is that the governments engaged in the World War turned back on the market a surplus stock, principally of acetate of lime, of which we are informed today there is very little left. Charcoal has been selling freely, so much that there is not any amount left in storage in any of the factories. There is very little demand just now for alcohol, though it has a moderate sale. There is a large amount of acetate of lime stored at present and inquiries show that sales have been a little improved in the last thirty days.

"There is no other plan at present than a general shutdown and this may continue for at least six months. All the factories are having careful attention as to watchman service and all fire-fighting appliances are kept in order. During this period many improvements and alterations and repairs will be made. It always has been the practice to shut down for sixty days in nearly every year for repairs.

"We believe the ownership in the case of every one of the factories insured is in excellent financial condition and that this lull in business causes no serious embarrassment. In our opinion everything is O. K., both morally and physically, and as shutdown permits will be issued monthly, the companies will be fully conversant with the situation."

The School of Technology of the College of the City of New York

The College of the City of New York now confers through the School of Technology degrees in Chemical, Civil, Electrical, and Mechanical Engineering.

These technical courses, as established, cover a period of five years. During the first two years the work required consists almost entirely of prescribed collegiate science subjects. The third and fourth year subjects are to a very great extent strictly engineering, but so arranged that the student is upon completion of the fourth year eligible for the degree of Bachelor of Science. Then after an additional or fifth year of purely advanced subjects he receives the degree of Chemical, Civil, Electrical or Mechanical Engineer.

The College has for years been offering most of these subjects, so that they are by no means new or experimental. In each instance the ground covered by the course has been carefully studied by a corps of well-equipped technical instructors, each one thoroughly conversant with his particular branch. The purpose is to make the course fundamental rather than intensive along any particular line. In addition to the usual day courses all of the subjects in the engineering courses also will be given evenings for the benefit of those employed during the day.

B. A. Deal, Jr., Nashville, Ga., H. F. Hogeborn, Savannah, Ga., and H. D. Elliott, Salisbury, Md., have incorporated the American Pine Products Refining Co., with a capital of \$250,000.

Solvents Produced by Bacteria

By H. E. Hall

Commercial Solvents Corporation

THE usefulness of every raw material in the chemical industry depends very largely either on its solubility in or its power to dissolve other materials. Water, of course, is the most common solvent, after which ranks ethyl alcohol. Production in large quantities at a reasonable price, wide use for many important raw materials and potability place ethyl alcohol as an industrial solvent in an exceptional commercial position.

In addition to certain alcohols and their derivatives, distillation products of petroleum and coal should be included among the most important of our industrial solvents.

With the exception of ethyl alcohol, none of these materials are potable and yet most of them may be and are used to advantage in numerous edible products. Their use in this regard often entails a change in chemical composition to other useful forms or they frequently are used as "vehicles" to convey certain soluble materials into the finished products after the performance of which function the solvents are removed.

It is remarkable that of the saturated alcohols important as industrial solvents, methanol stubbornly has refused to appear as a product of fermentation. Propyl, butyl and amyl alcohols as bacteriological products are recent additions of commercial importance to the list of industrial solvents.

The war developed in the United States a bacteriological process from which are obtained acetone and butanol (normal butyl alcohol).

Weizmann Process

During the war the need of the Allies for pure acetone as a solvent for both nitro-cellulose and cellulose acetate caused the American and British Governments to install the process devised by Dr. Charles Weizmann in several large plants in England, France, Canada and the United States.

Dr. Weizmann's process is the subject of U. S. patent No. 1,315,585, issued Sept. 9, 1919. In his description of the process, he makes a clear distinction between the bacteria isolated and used by himself and the butylic bacillus of Fitz claimed under the Fernbach U. S. Patent, 1,044,368 issued November 12, 1912, and which require for fermentative action strictly anaerobic conditions in closed vessels. The bacteria isolated by Weizmann from soil and cereals, e. g., maize, rice, flax, etc., work successfully under both aerobic and anaerobic conditions. The method of isolation is as follows:

From a number (say 100) of cultures prepared by inoculating at 90-100° C. dilute, sterile maize mash with some maize meal and allowing fermentation at 35-37° C. to proceed for 4-5 days, those are selected which show the most vigorous fermentation and most pronounced odor of butanol. These selected cultures are heated to 90-100° C. for 1-2 minutes. Many of the bacteria are destroyed but the desired resistant spores remain. A sub-culture is obtained by inoculating sterilized maize mash with a culture treated as just described. This sub-culture is treated in the same manner as the original culture and used to inoculate other sterilized maize mash, the process being repeated a great number of times. The bacteria thus obtained produce acetone and alcohol under aerobic conditions.

Procedure of the Weizmann Process

It is fortunate that Weizmann's process resembled in a general way the process of producing ethyl alcohol by fermentation of cereal grains. It readily was seen that plants equipped to manufacture ethyl alcohol could be transformed economically and quickly into efficient units for the production of acetone and butanol.

The extension of the utilization of bacteria in industrial processes is one of the triumphs of applied science induced by the exigencies of war, and requires a degree of refinement and precaution absent in processes not involving the vital principle of life.

The process comprises four stages, viz., (1) production of sterile, thoroughly cooked mash, (2) production of the seed or pure culture, (3) fermentation, and (4) separation of the acetone, butanol and ethyl alcohol from the "beer" by distillation.

The first step is carried out by the usual milling of the corn or other grain used. The meal is then mixed with water, the rough proportion being 100 parts by weight of maize to 1,500 parts by weight of water, and cooked under pressure in closed tanks equipped with stirrers. After thorough cooking and sterilization, lasting three to four hours at a temperature of 130-140° C. and under 2-3 atmospheres pressure, the mash is passed through coolers which reduce the temperature to 35-36° C., into large fermentation tanks where it is inoculated with the culture.

Fermentation sets in after five to ten hours and proceeds vigorously for about thirty-six hours, falling off rapidly after this period and reaching completion in about forty-eight hours. The mash is then distilled and the products isolated by fractional distillation.

Of the total solvents obtained, 56 per cent. is butanol, 32 per cent. acetone and 12 per cent. ethyl alcohol. There are approximately ten pounds of combined solvents produced from each bushel of corn used.

Distribution of War Stocks of Butanol

At the close of the war, the Allied Governments found very large stocks of butanol still in their hands. Its desirability for solvent uses in the "Pyroxylin" industries already was known and these stocks were marketed in this field without much delay. Its availability has caused chemists in various industries to investigate the properties of butanol and its derivatives. Since the armistice, approximately 20,000,000 lbs. of butanol have been marketed in the United States.

The manufacture of a very pure grade of methyl-ethyl-ketone from butanol had been successfully carried out by the Allies during the war and it was expected that supplies of this excellent solvent would greatly relieve the acetone shortage, had the war continued.

Properties and Uses

Butanol is a solvent for most of the important gums and resins used in the paint and varnish industry. It is readily miscible with many other oils and liquids and the fact that it is non-hygroscopic and miscible in very limited proportion with water adds to its importance and desirability in the varnish, paint and pyroxylin industries. In addition the field of application of butanol and its derivatives includes the manufacture of drugs, pharmaceuticals, perfumes, flavoring extracts, rubber goods and many other products.

Derivatives

Butylene and butane gases derived from butanol are being investigated. The desirable properties of these gases would appear to warrant further development and use in industrial fields. The chlorination products of butanol and butylene are newly developed solvents possessing a wide range of industrial application.

Among the derivatives of butanol which possess properties adapting them for use as camphor substitutes in the manufacture of pyroxylin products are butyl tartrate and butyl oxalate. Butyl tartrate appears to possess the most desirable properties in this respect. Its extended use would appear to depend largely on the price of tartaric acid.

Butyl acetate is comparable in properties and solvent power to amyl acetate and in fact resembles it so closely that a chemical analysis is necessary to distinguish between the two.

Butanol and butyl acetate came into the market at the time of an acute shortage of fusel oil and amyl acetate. The close resemblance between butanol and refined fusel oil, and between butyl acetate and amyl acetate made it relatively easy to disguise sales of butanol as refined fusel oil and particularly easy to disguise sales of butyl acetate as amyl acetate. The high price of fusel oil, as compared with butanol, added to the temptation of selling so-called amyl acetate which really consisted of an overwhelming percentage of butyl acetate and thereby obtaining correspondingly large profits.

It is unfortunate that this state of affairs exists because the result has been that butanol and butyl acetate are erroneously regarded by some to be much inferior in solvent properties to fusel oil and amyl acetate.

Purchase of Solvents on Specifications

Many manufacturers using pyroxylin solutions and dopes have for years specified "Amyl Acetate Solutions." The writer recognizes the value of amyl acetate as a pyroxylin solvent, but ventures the suggestion that users of amyl acetate solutions would do well to investigate the comparative merits of butyl acetate and other cheaper high-boiling solvents and the resultant saving of money.

The manufacture of pyroxylin solvents and dopes is attended with a considerable amount of undesirable secrecy and some unfortunate misrepresentation. For instance, the term "commercial ethyl acetate" is generally recognized to indicate a product consisting of approximately 25 per cent. ester, 14 per cent. ethyl alcohol and approximately 1 per cent. water. At one time the writer had analyzed an assortment of samples of "commercial ethyl acetate." The boiling point of pure ethyl acetate is approximately 78° C. The boiling ranges of some of the samples taken were surprising. Some of them started to boil at 52° C. while at a temperature of 92° C. there still remained several cubic centimeters of the sample in the distillation flask.

An analysis of the ester-content revealed one of the samples to contain 46 per cent. ethyl acetate. The remainder consisted of a troublesome mixture of water, ethyl alcohol, benzol, kerosene, aldehyde and one or two other cheap diluents added apparently for good measure.

This astonishing mixture was, of course, a ready solvent for pyroxylin, but the consumer had paid ethyl acetate prices for a product containing less than 50 per cent. ester; the impurities found were in every case diluents selling at prices averaging less than half the price of ethyl acetate.

The writer also has had analyzed samples of amyl

acetate and in many cases the consumer had paid amyl acetate prices for a product which actually contained less than 20 per cent. of amyl acetate. The remainder was made up largely of butyl acetate and even some ethyl acetate was encountered.

It is true that these solvent mixtures misrepresented and sold as a particular product will as a rule do the work intended. But the point which I wish to make is this: When buying solvents, determine, first of all, what solvent or solvents you actually can use to best advantage. Then, buy on specification, not on name. If, for instance, you find you can use a mixture of 75 per cent. ethyl acetate and 25 per cent. benzol, make your own analysis of this mixture, draw up a set of specifications to cover the case and place your order accordingly. By this means you will not be paying ethyl acetate prices for each percentage of cheaper material contained in the mixtures.

This same line of reasoning may well be applied to the purchase of all solvents, diluents and thinners used particularly in the pyroxylin industries.

It is encouraging to note that each year more and more of the large solvent users are including in their contracts lists of specifications and it is hoped through this means that the evils of selling doped-up solvent mixtures under assumed names shortly will be eliminated.

I have used considerable space in indicting the solvent manufacturer who misrepresents his goods, but by no means do I wish to leave the impression that all solvent manufacturers are unreliable or that even the majority subscribe to the above described business tactics. It is earnestly hoped, however, that these matters will be taken to heart by all solvent-users and that a basis of honest representation will be established throughout the trade.

New Solvents

Among other new solvents which are making their appearance in the industrial field are diacetone alcohol and isopropyl alcohol. The first, like acetone, is a solvent for both the nitrate and acetate of cellulose. There are at least two approved methods of manufacturing this material and its field of usefulness would seem to depend largely upon production costs. With acetone, the principal raw material, available at unusually low prices, it would seem an opportune time to develop the possibilities of diacetone alcohol.

We are told that isopropyl alcohol can now be produced economically from petroleum. The alcohol being miscible in all proportions with water appears to resemble in properties ethyl alcohol rather more closely than it does butanol or fusel oil. Isopropyl alcohol is not potable and since it possesses valuable solvent properties, its field of usefulness might well cover some of the fields now using denatured ethyl alcohol. The extent to which it will replace denatured alcohol will probably depend largely on the relative prices of these two products.

In spite of the numerous solvent products now available for use on a large scale, the hunt for new and better solvents is still continuing and probably will continue with the development of the chemical industry.

Standard Chemical Works, Reading, Pa., has placed in operation a new insecticide plant at Womelsdorf, Pa.

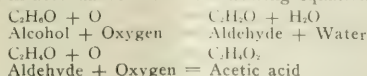
A. H. Kuhlmann, Inc., margarin manufacturers, Baltimore, Md., will increase its production facilities by the erection of an additional factory providing a total monthly capacity of 800,000 lbs.

Vinegar Manufacture in the United States

By Paul Hassack

Fermentation Chemist and Consulting Engineer

IN the manufacture of fermented vinegar, whether spirit, cider, malt, cereal, wine or other fruit juices, the base always is sugar or saccharified starch, which after conversion into alcohol by yeast is oxidized into vinegar by the activity of micro-organisms, the vinegar bacteria, in accordance with the following equations:



The chemical change of alcohol into acetic acid (vinegar) takes place spontaneously in the souring of fermented wine or fruit juices, which by contact or intentional exposure to the air become infected by the omnipresent carriers of the acetic fermentation.

Classes of Commercial Vinegar

The quality of vinegar, its aromatic properties due to esters formed during the acetifying process, depends upon the character and quality of the raw materials used and, of course, whether raw fermented mashes or distilled diluted liquids are subject to acetification.

Typical vinegars made from fermented raw mashes are malt, cider and wine vinegars or those made from melon or other fermented fruit juices; also from sugar syrups such as molasses or glucose, which have not been subjected to distillation. This branch of vinegar-making is characterized by the limitation of acidity by the alcoholic content of the vinous product, which again is governed by the natural sugar content in the case of fruit juices and in the case of cereal or sugar mashes by certain specific gravity limits of the fermented, undistilled product suitable for conversion into vinegar. For these reasons commercial cider, malt or sugar vinegars rarely enter commerce with any higher acidity than 5 per cent, whereas the highest acidity of vinegars made from diluted, distilled alcohol is limited by the disinclination of the vinegar bacteria to thrive in media of higher concentration than 12-14 per cent.

Progress in the Art

From biblical times up to about 150 years ago, vinegar had been produced in the most primitive and simple manner by exposing fermented wine to free contact with warm air. Our present manufacturing methods, though vastly improved mechanically as well as biologically, are based upon this ancient procedure. Our progress consists only in accelerating the process about tenfold compared with the natural course of the acetic fermentation carried out in home industry or commercially by the vinegar brewer of times past, and differing only in the mode of execution whereby weak alcoholic solutions (containing from 5 to 15 per cent by volume of alcohol) are exposed to fast currents of air on a large porous surface which has been inoculated with vinegar bacteria in a suitably constructed fermenter termed a vinegar generator.

A vinegar generator is an upright tank, in height preferably of three to four times its diameter, filled with porous packing such as spiral beech shavings, rattan waste, corn cobs, coke or charcoal or other ma-

terial upon which the vinegar bacteria lodge and propagate in an alcoholic medium continuously irrigating the packing and which, while slowing percolating downward, meets a current of air passing upward. The air is supplied through a number of adjustable air holes in the generator circumference near the bottom.

Production Conditions

While the manufacture of fermented vinegar either by the obsolete slow methods or by the modern generating process has all the aspects of being a simple affair, many startling details, commercial and technical, must be well considered by those interested in engaging in this enterprise, especially under existing conditions of raw material costs, labor, power, transportation, competition, etc.

Excessive shrinkages and quantitative losses caused by evaporation, defective yields, handling and re-handling of material in process or in the form of finished goods and other items later on referred to must be eliminated wherever possible by the most efficient procedure in factory location and design and lay-out of equipment. In brief, the less science and the more practical principles are practiced in the construction and operation of a modern vinegar factory centering in the utmost simplicity and easy control of details, the more assured will be its success.

Whether vinegar-making as the sole line of business is or is not remunerative depends upon a number of important considerations.

First a low cost of the raw material alcohol, be it in the form of apples for the manufacture of cinder vinegar, malt or cereals for producing malt or cereal vinegars, or molasses or sugar refuse for the manufacture of spirit vinegar.

Those manufacturers will be in the strongest position who are able to derive their alcohol as a by-product from the manufacture of other products, e.g., brewers of near-beers from the de-alcoholizing of their fully fermented beers, or yeast manufacturers from the distillation of the yeast-refuse washes after the yeast has been separated from the washes. In such instances the cost of vinegar represents only expenses incurred in the distillation and subsequent generating processes plus the labor and general overhead expense, whereas raw material cost is borne by the principal product, viz., the beer or yeast.

The advantage of the brewer or yeast manufacturer producing vinegar as a side line over the vinegar manufacturer compelled to buy either molasses or grains as raw material is clearly established and control of market prices naturally rests with them, for practically whatever they choose to charge for their vinegar is at least 75 per cent clear profit.

Vinegar from Black Strap

The usual spirit-vinegar manufacturer uses black strap molasses as raw material. The molasses is dissolved in about 4-5 times its bulk of hot water; the resulting solution if then cooled to about 85° F. and run into a fermenter where it is pitched with brewers', distillers' or compressed yeast and usually within 72-84 hours fermentation is completed down to 2-3 per cent

Balling, when it is pumped into a low-wine still and the alcohol vapors expelled into open condensers filled with cold water and kept at low temperature during distillation. The resulting product is termed low-wine.

Under the regulations of the Internal Revenue Department only open condensers for making low-wines in vinegar factories are permissible. The average yield of low-wines from 100 gallons of black strap molasses, worth at present between 10-13c. per gallon, varies according to the sugar content and guidance of the fermentation process, from 250-280 gallons of 23-25-proof alcohol or an equivalent of 28-35 gallons of absolute alcohol.

Based upon practical operating figures the cost per gallon of 10 per cent vinegar for raw material alone amounts to about 3c. per gallon, which is frequently more than doubled and in some instances even tripled by losses in process and overhead expenses; this fact reinforces strongly the advantage of the brewer or yeast manufacturer operating a vinegar factory as a side line over the average spirit vinegar manufacturer.

The alcohol used for the manufacture of spirit vinegar is tax-free under application for special permit for the manufacture of low-wine for vinegar-making.

Every gallon of 25-proof low-wine (12.5 per cent alcohol by volume) will yield practically under customary factory methods about 0.7 to 0.8 gallon of 10 per cent spirit vinegar; or reversing the calculation, inclusive of all process losses, 1 1/4-1 2/5 gallons of 25-proof low-wine will produce one gallon of 10 per cent spirit vinegar.

These figures show that 100 gallons of molasses furnish from 200-230 gallons of 10 per cent spirit vinegar.

Aside of the fact that theoretical yields will never tally with the results attained in actual practice, it is emphasized that with certain modern improvements adopted by vinegar manufacturers in the generating process, on which topic reference will be made later in this article, by far higher yields become attainable.

Vinegar from Corn or Grain

Higher grades of spirit vinegar are produced by the use of corn or grains as raw material. A mash composed of 85 per cent corn, 10 per cent rye and 5 per cent malt (sprouted barley) in the proportion of 45 gallons of water for every bushel of grain, is cooked in a mash tub equipped with mechanical agitator and provided with a cooling coil in a manner not to conflict with special regulations of the Internal Revenue Department.

The milled corn is cooked and coarse rye meal stirred with the corn. The mixture is well boiled. Malt next is added to hydrolize the starch to sugar, the complete conversion being determined by the iodine test. The mash is cooled slowly to about 75° F., conveyed to a fermenter where it is pitched with an ample culture of strongly fermenting pure distillers' yeast.

After the sugar is fermented the mash is sent to the still as described before and converted into low-wine, and subsequently into spirit vinegar by the generating process.

Vinegar from Malt

In the manufacture of malt vinegar we make a malt mash by mashing about 5 2/3 bushels of distillers' malt in 100 gallons water whereby a wort of specific gravity 1.057, which is equivalent to 14 per cent Balling and

indicative of 11.8 per cent sugar-content, is obtained. It is of elementary importance in the manufacture of malt vinegar to conduct the mashing process at a low temperature to avoid destruction of the diastase, for thereby only is it possible to ferment a malt infusion completely dry. From the above mashing example a malt mash containing 6 per cent of alcohol will result, which in turn will produce 5 per cent malt vinegar.

All raw mashes made for direct acetification over generators should be clarified by fining, filtration or centrifuging prior to generating. It is at times found difficult to ferment glucose or molasses mashes as dry as apple juices or malt mashes, which is due partly to lack of acidity and the absence of nutritive elements for the yeast, hence correspondingly lower yields are due to incomplete fermentation.

Vinegar from Cider

Where the object of a manufacturer centers in the manufacture of apple products, it must be distinctly understood that no graver mistake could be committed than to make the manufacture of cider vinegar the chief issue; it is, however, important enough to be considered as a side line of strictly defined proportions if it is possible to manufacture cider vinegar throughout the whole year.

Lower grade apples unfit for sweet cider, second-pressing stock or apple juice which in spite of all precautions, such as chemical or heat sterilization, become unfit for sweet cider by reason of alcoholic fermentation above the ominous 1-2 of 1 per cent under the Volstead act or because of acetification turning the product sour, can be advantageously converted into cider vinegar.

In any well-conducted cider mill, more so now than ever before, the most lucrative branch is the manufacture of sweet refined apple juice clarified, filtered, bottled and pasteurized in the bottle or in bulk under up-to-date methods.

When the juice extraction from the apple is executed by the generally employed hydraulic pressing method, the juice yield obtained from one ton of average good cider apples varies from 150 to 160 gallons. The sugar-content of average apple juice amounts to about 10-12 and even as high as 15 per cent which yielding about 50 per cent of alcohol after complete spontaneous fermentation furnishes a wine from 5.6 and as high as 7.5 per cent alcohol by volume and 0.5-1 per cent acidity. This apple wine, termed vinegar stock, is clarified either by long storage or by filtration before it is subject to acetification on the vinegar generator.

As regards demand spirit vinegar is of foremost importance, closely followed by cider or apple vinegar and in the third place malt vinegar.

Wine vinegars are comparatively little in demand in the United States, which does not mean, however, that a market for a high quality product could not be created. It is a neglected branch of vinegar-making in this country. Vinegar made from undistilled molasses does not amount to a great deal as far as quantity consumption is concerned, and while correctly branded by the manufacturer and dealer it frequently is sold deceptively as cider vinegar.

An interesting new product is melon vinegar introduced in the South in the past few years. This field of manufacture is deserving of further development from a national economic standpoint, since every bit of the fruit, juice, rind and seeds, can be turned into commercial values.

General Irregularity in Production and Demand

The vinegar industry has its share of seasonal irregularities of production and demand. The demand is greatest during the warm months, May to October, during which period production capacity is reduced by conditions unfavorable to bacterial action; while during the cool months curtailed demand accompanies increased production. This necessitates provision for a large storage capacity to hold over a 4 to 6 months' winter production for sale during the warm season.

Manufacturers not having ample storage tanks to meet this contingency invariably find themselves forced to antagonize nature by curtailing production during winter, and then try to force a high production during the summer months to meet the demand. In consequence of this perversity, it happens that such factories operate at a great disadvantage and with losses arising from disturbances and irregularities of the acetic fermentation. Those contemplating engaging in the manufacture of vinegar should study closely the possibilities of disposing of a given yearly output in local markets and cover the same by contracts and, as a safety valve, to engage also in related industries such as pickling, preserving, table sauce or mustard-making, wherein a given quantity of their own vinegar can be made use of to additional advantage.

In the strictly chemical industries vinegar is but little used at present with only one notable exception during the war and the shortage of acetate of lime for the manufacture of acetone, indispensable as a solvent in the manufacture of Cordite and smokeless powder, when I was called on to design, erect and operate two spirit vinegar factories of gigantic proportions such as had never before been considered feasible, inasmuch as the output of both plants at Curtis Bay, Md., amounted to about 100 million gallons of vinegar per year, which is the approximate equivalent of 66 million pounds of acetic acid. Every drop of this vinegar was immediately turned into acetone and absorbed by the war industries. This use of vinegar was an anomaly, the plant a war baby, and was shut down from the moment the armistice was signed.

Generator Design

Regardless of the kind of fermented vinegar made, the fundamental commercial consideration is the quick generating process for the acetification of alcoholic mash. In regard to the most suitable generator types and sizes a wide difference of opinion exists. What is termed in the United States a "standard generator" is an upright wooden tank of from 3-4 feet in diameter and 8-10 feet high.

About 6-10 inches from the bottom of the tank a false bottom is placed upon which the porous generator packing, spiral beech shavings, rattan, corn cobs, charcoal or coke, rests, which packing extends up to about 8-10 inches from the top, where a perforated false top head is tightly fitted into the generator staves. On top of this distributing head a wooden or earthenware tilting trough, called a dumper, is placed, which when filled by gravity with the vinegar mash alternately discharges its contents in either direction. The liquid mash trickling through the perforations of the false top head is in this manner evenly distributed over the generator packing in periodically timed intervals.

The productive capacity of a standard generator of 4 ft. diam. by 10 ft. high, with a packing column amounting to approximately 100 cubic feet, varies from 5-8 gallons of 9-10 per cent spirit vinegar per 24 hours. More correctly expressed, it will oxidize 5-8 gallons of

25-proof (12½ per cent alcohol by volume) of low-wine which is the equivalent of 4.16-6.66 pounds of absolute alcohol.

Beneath the false bottom a number of small draught holes drilled through the tank staves are provided to permit the entrance of atmospheric air and a vivid draught is noticeable with all well-working generators, a flame held near it being drawn in.

The draught is caused by the biological energy of billions of active vinegar bacteria which asserts itself in liberation of heat. The air thus warmed ascends and draws in the cold outside air.

The air in passing through the generator is partly deprived of oxygen, and escapes through outlet holes in the generator cover, carrying off a certain percentage of alcohol and acetic vapors formed in the oxidizing process.

The operation of small units, such as is represented by the still widely used standard vinegar generator, is a vestige of the past, when up to about 70 years ago, and before automatic generator infusion devices came into use, the work of irrigating the packing with alcoholic mash was done by manual labor, whereby the operator lifted by pail the mash up to the top of the generator tank.

To facilitate this heavy work which, on account of the acid-saturated atmosphere in the vinegar rooms of the past, was doubly obnoxious, low generator types were favored and from those days up to the present the myth of the benefit of small units was maintained in the face of the fact that the small unit has outlived its utility. Every practical vinegar manufacturer knows and suffers under the disadvantage of operating a large number of small generators.

Thus where 8 or 10 large type generators would accomplish the work in a most simple and economical manner, 100 generators are still now generally used by those who never learn. Only English malt vinegar manufacturers and the American cider vinegar industry emancipated themselves largely from tradition and fared well in the operation of large generator types of 6-8 feet in diameter and 16-20 feet high, and operated by mechanical infusion devices.

To the writer, large generator types in connection with spirit, malt and cider vinegar were not a novelty for as long as 35 years ago a large factory in Heilbronn, where about 150 generators of 7 feet in diameter and 19 feet in height were operated under his supervision, spirit vinegar of 12 per cent concentration was produced in large quantities. Therefore, when the call came at the outbreak of the war for the construction of the immense vinegar plant mentioned before, the writer did not hesitate a moment to insist on adopting still larger types than anybody ever dared to employ, and within a year had 960 generators of 10 feet in diameter by 18 feet high, and 200 still larger generators 25 feet in diameter and 20 feet high in full and successful operation, after he had positively declined to erect about thirty thousand standard generators which would have been required to furnish the equivalent amount of vinegar desired.

This attainment notable in the annals of vinegar making demonstrated the superiority, simplicity, safety and economy in the operation of large type generators. The larger the generator, the more imperative it is to provide free circulation of air within and to pay attention to the manner in which the packing is placed in the generator.

In the course of time any generator packing loosely put into the generator will settle, even with small standard types, and impede the circulation of air. Re-

gardless of the dimensions of generators, this disadvantage can be avoided readily by shelving the packing in case spiral beech shavings, corn cobs or coke is used or by adopting rattan packing which the writer deems far superior to any other material used for the purpose, if applied right.

The only manner in which rattan packing will give perfect satisfaction in operative results consists in winding the coarse and long rattan fibres around square poles through which cross-in dowels are driven to support the rattan which is firmly wound around the poles by means of a simply constructed winding machine.

The wound poles are placed into the generator tank perpendicularly and firmly wedged into same. The poles are of a length to correspond to the height of the generator; with large generators it is best to pack in two or three tiers. For every 100 cubic feet of the packing column about 600 lbs. of rattan are required. This method of packing is not only the technically most advanced way of assuring permanency, but has the additional advantage of only about one-third the cost of any known packing material.

Generator Operation

With large generators it is of advantage to provide a simple system of wooden air tubings within the generator by means of which fresh air is conveyed readily to any part of the generator, whereby every cubic inch of the packing is turned into productive soil. A vinegar generator may be compared to a furnace. Without perfect regulation of the air supply, either incomplete or too rapid combustion will take place. Under quite similar conditions occurs the oxidation of alcohol into acetic acid in vinegar generators. The draught must always come from below the grate. If we open the damper door of our furnace we reduce the energy of combustion by reducing the draught. Likewise, air holes drilled in the upper part of the generator tank with the intention of injecting air to the upper regions of the packing column accomplishes just the contrary, and reduces the draught in the same way as does a furnace damper.

The reclaiming of all or at least a part of the vapors formed in the course of the generating process, which is not feasible with a large number of small generator units, meets no difficulties with the larger types. The importance of this feature is hardly realized by the average vinegar-maker of the old school who is accustomed to consider as a matter of course these sometimes exorbitant losses, which amount at times to 20 per cent of the yearly production. Excessive evaporating losses are no longer justifiable in the manufacture of fermented vinegar.

Irrespective of the size of generators, the best method of operation is the single run plan. To make this plain, I shall explain briefly that in former years, and even yet, the tandem-generator system has been widely employed before it was realized that this complication was unnecessary.

Imposed by antiquated doctrines the belief was prevalent that strong vinegar could be produced only by running the unfinished product of the first generator or the first group of generators, over another one. Sometimes even three or four generators were combined in a battery, the last one only furnished the finished vinegar.

While the operation of tandem generators appears in a way justifiable in the acetification of young and cloudy cider vinegar stock which, when run over the first generator, becomes not only partly acetified, but also clarified by the capillary attraction of the porous packing in

a similar manner as beer in the chip cask, there is not the shadow of necessity nor advantage in so doing, for the rational method calls for sedimentation, centrifuging, fining or filtration of cloudy stock. It is wrong to use a generator as a depository for impurities since the inclination of mashies, heavy in vegetable matter unavoidably created in the forming of mucous growths, the so-called vinegar-mother, is to soil the packing in course of time.

Single generator operation is the exclusive method to be advocated; the composition of the generator-feeding mix and the quantity of the mix charged within 24 hours govern the principle.

It has been established scientifically as well as in practical operations that mashies containing not more than 2-3 per cent by volume of alcohol, with a predominating amount of acidity, will oxidize very readily, inasmuch as they are easily digested by the vinegar bacteria in certain proportions prevailing in their nutritive element, i.e., in the feeding mixes. To illustrate: When the object is to produce 10 per cent spirit vinegar, a mix composition of about 8.2 per cent acidity and from 2-2.6 per cent by volume of alcohol will be found to yield good results. It is easy to compose these proportions by mixing low wines of a corresponding concentration with finished vinegar from the generators. In other words, in any vinegar factory a given quantity of vinegar is at all times kept in circulation for the setting of the feeding mixes.

In cider vinegar factories operated on the single-run plan to produce 5-5½ per cent vinegar feeding mixes of 3.4-3.75 per cent in acidity and 2-2.6 per cent alcohol by volume are a readily convertible proportion.

In proper relationship to the correct composition of the feeding mix must be the liquid quantity which is charged to each generator within the time interval of 24 hours.

How many gallons of the feeding mix may be charged in the course of an operating day depends on the cubic contents of the packing column within the generator. It varies with spirit-vinegar generators from 18-26 gallons and for cider and malt vinegar generators from 50-75 gallons for every 100 cubic feet of actual fermentation space.

It is dependent largely upon the density of the packing column and in turn upon the free circulation of air within the same, which control the intensity of the fermentation. In the manufacture of spirit vinegar it is necessary also to provide proper germ food in the form of carbohydrates and phosphates for the sustenance of the energy of the vinegar bacteria; with cider or malt vinegar generators germ food is contained in abundance in the feeding mashies.

The design and operation of the mechanical mix-feeding devices are an important consideration. For smaller generators, from 3-5 ft. in diam., the use of a perforated false top-head in conjunction with a stone-ware tilting trough, is preferred. For generators of a diameter from 5-25 ft., whether for cider, malt or spirit vinegar, the automatically operated sprinkler is the most satisfactory device. Assisted by this faultlessly functioning charging device, the operator of a vinegar factory has at all times the course of fermentation firmly in hand, which is important in view of the fact that the operation of generators is a continuous process day and night throughout the year. Guesswork in the operation of spirit, cider or malt vinegar generators is positively out of place and is almost always responsible for minor and grave disturbances of the acetic fermentation in the generating process.

Technical Control

The conduct of a modern, well equipped vinegar plant, irrespective of size of the plant or dimensions of the generators, is comparatively easy. The larger the generators and the fewer the units, the easier become its operation and control. Success, however, is assured only when the operator keeps his eyes open and has a clear conception of the sensitive biological process.

It is necessary to watch the proper functioning of the mechanical infusion device, to observe strict cleanliness and furthermore to test the raw materials from which the vinegar is to be made and the vinegar itself.

It is strange to say that even at the present moment there are many vinegar manufacturers operating their plans arbitrarily, disregarding even the most rudimentary chemical tests of raw materials and finished products, to their own disadvantage, and for such causes of neglect often wonder why they cannot make their plant pay better.

Five chief tests necessary for the control of a vinegar plant for which chemical apparatus is required are:

1. A specific gravity, or Brix or Balling hydrometer, for the determination of sugar in the unfermented diluted molasses or saccharified grain mash, or of the sugar contained in freshly pressed apple juice. By knowing the content of fermentable sugar in any of these liquid materials the operator can calculate the amount of alcohol they will yield and from that also the acidity of the vinegar obtainable.

2. A low-wine alcoholometer (hydrometer) for the determination of the percentage of alcohol in distilled low-wines or diluted high-wines used in the manufacture of spirit vinegar.

3. A laboratory sample test still, with an accurate alcohol hydrometer, for the determination of alcohol in the generator feeding-mix, in fermented malt or cider vinegar stock as well as in the finished vinegar. This apparatus enables any one to carry out a correct alcohol test within 15 minutes.

4. An acetometer for the determination of the acidity of vinegar, of feeding-mixes, of cider or cider-vinegar stock, or, in fact, of any of the liquids containing acids.

5. A matter of considerable importance is the observation of thermometer indications in every vinegar generator and of the vinegar room, as well as that of the various liquids to be tested in the factory laboratory.

In large plants the necessary tests should be made every day; in smaller plants it suffices once or twice a week. The proper tabulation of the results of examination in simply kept factory records form a reliable permanent guide for the operator, and render it almost impossible on his part to be in doubt of what he has to do in order to keep the acetic fermentation in smooth working order by proper steps taken at the right time.

The results of correctly-made determinations of alcohol and acid in the feeding-mashes as compared with the analysis of the finished vinegar discharged from generators disclose the true course of the acetic fermentation, and must always tally within close limits. If a larger than usual amount of alcohol is found in the finished vinegar, it usually goes hand in hand with a decrease of the acidity.

If no alcohol at all is present in the finished product, the deduction is that the generator is able to convert more alcohol into vinegar than is charged to it and if this hint is not followed at once over-oxidation of the acid will inevitably occur, resulting in considerable losses of acid by destructive fermentation.

In brief, any generator must be furnished each day exactly the amount of alcohol that the activity of the bacteria is able to transform into acid.

To gauge this exactly is possible only by the regular execution of chemical tests.

Disturbances of the fermentation are always due either to a transgression or to incomplete utilization of the oxidizing capacity of a generator, which is a thing that cannot happen under careful observation and tests as above outlined.

Food Research Institute

AS result of an endowment of \$700,000, provided by the Carnegie Corporation at the initial suggestion of Herbert Hoover, the Food Research Institute, designed for the study of all problems of food production, distribution and consumption, is to be established at Leland Stanford Junior University.

Under the terms of the agreement with the Carnegie Corporation the university agrees to establish a research organization under the name of the Food Research Institute of Leland Stanford Junior University and to appoint three scientists to be known as Directors of the Institute. These directors will have authority to determine the scientific policies of the Institute and the problems to be studied. It is the hope of the Carnegie Corporation that eventually the new organization will be known as the Hoover Institute.

There will also be an advisory committee made up of men of national prominence, representing production, distribution, consumption are other groups of the community, one of whom will be Mr. Hoover. The university will appoint seven members of this body, who, with the president of the university ex officio and the president of the Carnegie Corporation ex officio, will make the committee number nine men. Each member will serve for a term of three years from the date of his appointment.

The Institute will begin its work on July 1 next, and the Carnegie Corporation will provide a fund of \$700,000 for its support for a period of ten years.

James R. Angell, President of the Carnegie Corporation, who has just been called to the presidency of Yale University, announces that Leland Stanford Junior University has agreed to make its scientific laboratories available to the Institute. It is not intended to duplicate the equipment of research laboratories working in the field of nutrition, but, so far as it is practicable, to have the Institute co-operate with other agencies working in the general field.

The directors to be appointed will head three separate divisions. One will be an expert in the field of physiology and chemistry of nutrition, one an expert in economics and food distribution, and one an expert in the chemistry of food manufacture and agriculture. They will work co-operatively from three avenues of approach upon fundamental issues of widest human significance. It is also provided that the Institute may receive from time to time such specially qualified students as it may be possible to instruct without disadvantage to the primary research purposes of the organization.

A small group of fellowships will be available for graduate students of high intellectual promise. These students will receive wholly unusual training for public service while at the same time contributing valuable assistance to the work of the Institute.

The Carnegie Corporation, after the Institute is once established, will abstain entirely from any attempt to direct or control its work.

Reactions of a Tariff on Oriental Oils

By John Aspegren

WE all appreciate the unequal operation of deflation and regret that in certain elements of our national activity it has run its full course, whereas in other basic lines of industry it is intentionally opposed with the result that its operation in inter-related lines is retarded. The general result is a slowing down of production consequent upon the inability of agricultural producers to market their products at a price that will permit them to buy the products of those lines that have not undergone a corresponding deflation.

Cottonseed oil producers are confronted with formidable importations of Oriental vegetable oils. Reduced oil consumption abroad adds to local stocks with the inevitable reaction upon the cotton farmer already suffering from a stagnant market for the cotton fibre at a figure below production cost.

The first remedy that suggests itself is a tariff on imported Oriental oils in the expectation that to shut them out of this country will increase the demand for cotton oil and hence raise the price to the Southern farmer.

It behooves us, however, before we argue for something that we are liable to get and later on regret, to analyze the situation so we may know what we are doing.

We imported Oriental and foreign oils during the season:

	Barrels.
1918-19	2,607,253
1919-20	2,239,070
And so far during five months of the season 1920-21	
—507,004 barrels, at which rate for the full season	
1920-21	1,216,812

As importations are dwindling the latter amount is liable to be reduced. The importation of foreign fats is entirely negligible.

As against the above we exported oils and fats as follows:

	Barrels.
1918-19	3,064,673
1919-20	2,897,616
And so far during five months of the season 1920-21	
—1,124,117 barrels, at which rate for the full season	
1920-21	2,697,876

The largest part of these exports were American products. It will, therefore, be seen that we export more oils and fats than we import.

The excess exports each season were as follows:

	Barrels.
1918-19	457,420
1919-20	658,546
And so far during five months of the season 1920-21	
—617,113 barrels, at which rate for the full season	
1920-21	1,481,064

Assuming that we put a high duty on these Oriental oils, what will happen? Take the extreme case that it would stop the importations altogether. That would mean that these Oriental oils instead of going to this country would seek their way to Europe instead. The price of Oriental oils would naturally decline due to the fact that they lost the American market. They would become more attractive to European consumers, who would buy them at a price. In other words, they would go to Europe instead of to us.

Now European buyers getting this oil, and getting it at a low price, quite a little below the parity at which American oils and fats are selling, would naturally require so much less American oils and fats. They would find American tallow too high. They would find Amer-

ican lard too high. They would find American cotton oil entirely out of reach. The natural result would be that we would entirely lose our exportations of cotton oil, and would, in addition to our present consumption, have to consume at home all the cotton oil we are now exporting.

Furthermore, on account of Europe not taking American lard this would be thrown on the domestic market and the price decline, so that we would have a lessened demand for compound lard, and only at a very much reduced price. Furthermore, Europe not buying American tallow it would be offered in the domestic market at a reduced price to the soap-maker.

In other words, instead of cotton oil facing the competition with the imported Oriental oils, we instead would find increased quantities of American-made lard, tallow, etc., thrown into competition with our cotton oil, besides which we would lose entirely the export business in cotton oil that has been built up during years of hard work.

The net result of it all would be that if we shut off importations of 1,000,000 barrels of Oriental oils, we would lose the same amount in exportations of cotton oils and other fats, and we would be no better off.

The net sum total would mean simply that we would shut off a certain amount of importation to this country, and an equal amount of exportations, and that this country would lose trade to that extent; that the amount thus imported and exported would simply go right around us and be handled by the refiners and soap-makers in England instead of by the refiners and soap-makers in America. British refiners would ridicule us for throwing away such business, and for wasting good American cotton oil when soya bean oil would be good enough. We would be committing suicide in regard to the export trade of high-grade cotton oil for butterine purposes.

The situation is further aggravated by the fact that very large quantities of imported Oriental oils come from Manila, and that probably their importation would not be affected by the proposed duty.

Lesser & MacGruer, Inc., and Sweetser & Bainbridge, Inc., have merged under the name of North Hudson Chemical Co., Inc., with plants at Albany and Watervliet, N. Y., and New York office at 56 Pine St. A new Albany plant costing \$100,000 is approaching completion.

* * *

The enterprise of carbon black interests in extending the utilization of natural gas to embrace service to regions adjacent to the gas fields is shown by the organization of the Louisiana Gas Distributing Corporation. This organization capitalized at \$10,000,000 will build pipe lines from the northeastern Louisiana and southern Arkansas gas fields to industrial centers in Louisiana, Mississippi, Tennessee and Arkansas.

The directorate includes: F. F. Curteeze of Erie, Pa., president of the Erie Trust Globe Iron Works; C. Harold Smith, president of Binney & Smith Company of New York; Judge Harlan of St. Louis, general counsel of one of the large tributary railroads and one of the promoters of the Monroe-Louisiana Carbon Co.; Godfrey L. Cabot of Boston, president of the Natural Gas Products Association, and representatives of the Southern Carbon Co. of Monroe, La.

Principles of Rubber Compounding

By H. E. Simmons

Professor of Chemistry, Municipal University of Akron, Ohio

THE art of rubber compounding has developed in the last few years from a rule-of-thumb procedure purely to the degree that today men are trained in the science of compounding.* In fact, we may go further and say that the large expenditure of money in the equipment of laboratories and in hiring men to operate them is simply for the benefit of the men who are in charge of the compounding.

For instance, we may find in a laboratory several men whose whole time is given over to routine work in the testing of crude rubbers, and for what reasons? That they may turn over some valuable information to the compounders. We find men, too, testing the purity of the pigments, again to be of assistance to the compounders. Today we find the large laboratories establishing and prosecuting work of a research nature along the line of organic accelerators. This, again, is done with the idea of gaining some knowledge that in the hands of their compounders will enable them to develop greater speed in curing and thus to increase production. The expenditure of large sums annually for research laboratories is justified by the progress made by the companies which maintain such laboratories.

Problems of the Compounder

It matters not in what particular line of work the compounding is being done, the same problems are ever before the compounder, whether he is engaged in compounding tires or toy balloons. The following points are all to be considered and each given its due attention:

I. Quality, including tensile strength, elasticity, grain, stretch, set, hardness, resistance to abrasion, to tearing, to cutting and deterioration due to ageing.

II. Adaptability of stock to the processes through which it must pass, such as milling, calendaring and spreading.

III. Length of time and conditions required for vulcanization.

IV. Compatibility with other stocks with which it is used.

An excellent example of this is found in the different stocks which must be developed in the construction of a solid tire, where it is necessary to produce a stock which will form a union with a metal base on one side and with the soft vulcanized tread on the other.

V. Color.

VI. Specific gravity.

VII. Cost.

Compounding Mechanical Goods

For the compounding of mechanical goods, the problem, with the exception of a few specials, presents itself as follows:

The compounder is advised of the terms called for by the specifications in a contract which includes price, delivery, specific gravity, color, and usually definite tests to which the article must be subjected and pass. He will, therefore, take the material available and meet the specifications with as much margin of quality as the price will allow. It is to his advantage to make the time of cure as short as possible in order that the equipment

may render the maximum possible production. Otherwise the conditions are the same as encountered in other stocks. We therefore shall discuss each point separately.

Tensile Strength

Tensile strength is determined mainly by the quality of the rubber used and the balance between the rubber and other compounding ingredients. This embraces all there is to be said of compounding, for in striking this balance, any or all of the properties in quality are developed. Tensile strength is acquired mainly by the use of zinc oxide and different grades of lampblack. Several other materials affect tensile strength more or less, but these two are in a class by themselves.

Resistance to abrasion, to tearing, etc., are very much allied to tensile strength, although the latter is by no means a measure of them. Zinc oxide is beyond question superior to all other materials for obtaining these qualities, consequently one almost never finds a rubber compound that does not contain zinc.

Grain is another close ally of the properties just mentioned. It is desirable to produce a stock which will have a grain that is more or less knotted up and consequently will prevent easy tearing.

With very few exceptions, the addition of other compounding ingredients to the rubber tends to cut down the strength. In the case of certain materials, such as inner tubes, surgical goods, toy balloons, etc., the stretch is highly desirable and for this reason in their manufacture very little filler may be used. Such as are used are mainly employed as coloring pigments. In this connection we may mention antimony, iron oxide, arsenic yellow, lampblack, litharge, and various organic pigments.

Occasionally where a cheap stock is desired, barytes may be used as a filler with very little effect upon the stretch; however, in the majority of uses for which a rubber compound is wanted, high stretch is undesirable. In tires, for instance, too high a degree of stretch would cause too much flexing, resulting in inner friction, which would cause the tire to go to pieces in a short time. No rule can be given for a proper balance in regard to this property since it must be worked out by actual experiment in each individual case.

Elasticity

Elasticity is measured inversely by the ratio of the work done in stretching to the work given back by the recovery. It is difficult to prophesy in advance just how a compound will conduct itself in this respect, except that most cheap fillers, like barytes, whiting, etc., have a tendency to decrease this ratio. "Set" is simply an approximate measure of elasticity.

Ageing Qualities

Deterioration of rubber articles on ageing is undoubtedly one of the most objectionable features. This deterioration may be due to several factors:

(a) Cure, either over-vulcanization or under-vulcanization.

(b) The quantity of sulphur present, either excess or deficit.

(c) Oxidation, which may be influenced by atmospheric conditions such as heat, light, humidity, alternate wetting and drying, gases in the atmosphere, or in special cases the influence of oils, or other chemicals

*Abstracted from "Rubber Manufacture." By H. E. Simmons, Professor of Chemistry, Municipal University of Akron, Ohio. 7 x 11, 149 pages, 58 illustrations. D. Van Nostrand Co., 8 Warren St., New York.

which may come in contact with the rubber accidentally or of necessity, as in the case where hose is turned to conduct acids or oils. Here special compounding is necessary to produce a more resistant compound.

By adaptability to working on the mill or calender, we mean that the compound must not be too soft, neither must it be too dry. In certain cases precaution must be taken to produce stock that will not scorch too readily. Again, in the case of frictions, it is necessary to produce the desired degree of tackiness for frictioning. In the tubing machine, some stocks may be too dry and thus come through rough; some may swell unevenly after coming through the die of the tubing machine. Some stocks will give trouble due to blooming when being calendered. This will cause poor unions in case it is used in laminated fabrications. Thus, if the stock is soft, either add some filler or remove some of the softeners. If too dry, the reverse of this undoubtedly will prove to be the remedy. "Mineral" rubber, vaseline, pitches, tar and cheap wild rubbers, and vegetable oils may be used for these purposes.

In a large number of cases it is necessary to cure two or more stocks of different nature together. The cure of each of these stocks must be regulated so that both will be cured properly during the same length of time. We will take, for example, solid tire stocks. Here the volume of rubber is so great that there is a tendency for the outside to cure more rapidly than the inner part unless the time of vulcanization is long enough to permit the whole mass to acquire the same temperature and remain at this temperature long enough so that the time to heat through and to cool off in the center will approximately balance.

Then, again, where tires are vulcanized by the two-cure process, the carcass gets a fair degree of cure in the first heat but must retain the property of holding its shape and at the same time that of uniting with the tread rubber during the second cure. The tread rubber, on the other hand, must take a "set" cure very quickly and be able to hold its shape and form a union with that already in the carcass. These properties may be obtained by proper manipulation of the sulphur content and by the use of suitable accelerators.

Colors

The next point is that of color. Here the compounder is asked either to duplicate a certain stock as to color or to produce a stock of certain color. This is a point which is most important in mechanical goods. Of course, the trade may become prejudiced in favor of a certain color in treads or a certain color of inner tubes, but the choice is limited to a very few shades, while in the case of balloons, variety of tints is to be desired.

The number of colors available when only inorganic fillers were used restricted the selection very much, but today with the use of organic dyes many different shades and tints are possible. When compounding to match a certain shade, one often encounters difficulty for it cannot always be foretold just what effect the process of vulcanization is going to have upon the particular color pigments which are added. Especially is this true of certain organic ones.

Specific Gravity

Very often the compounder is asked to produce a stock of a certain specific gravity. This is done by having at hand a knowledge of the specific gravities of the different materials used in compounding. In this connection we will give an example. For instance, it is desired to produce a stock having a specific gravity of

1.59. Let us assume that the purpose for which this stock is to be used will allow the compounder to use fine Para, zinc oxide and sulphur. This is a very simple formula and the principle involved may be better grasped from it. The compounder arranges his data in the following manner:

Material	Weight	Sp. Gr.	Volume	Cost	Cost of Weight
Fina Para ...	50	.89	56.1	\$.81	\$40.50
Zinc oxide ...	x	5.35	x/535	.10	5.49
Sulphur	3	1.98	1.51	.04	.12
	107.9				\$46.11

From his experience he concludes that he will use 50 parts of rubber with a specific gravity of .89, and to cure this three parts of sulphur with a specific gravity of 1.98. The question that remains is to determine the amount of zinc oxide necessary to give the stock a gravity of 1.59. In other words, the amount of zinc oxide is an unknown quantity, but it has a gravity of 5.35.

Now $\text{Volume} = \text{Wt.} \div \text{Sp. Gr.}$; therefore, the volume of rubber is equal to $50 \div .89 = 56.1$. The volume of zinc oxide is equal to $x \div 5.35$; the volume of sulphur is equal to $3 \div 1.98 = 1.51$.

Now the total weight of the compound as taken is $50 + x + 3 = 53 + x$. Its volume is

$$56.1 + \frac{x}{5.35} + 1.51 = 57.61 + \frac{x}{5.35}$$

Since $\text{Vol.} = \text{Wt.} \div \text{Sp. Gr.}$ and $\text{Sp. Gr.} = \text{Wt.} \div \text{Vol.}$, therefore $\text{Weight} = 53 + x$ and $\text{Volume} = 57.61 + x \div 5.35$.

Thus 1.59 (the desired Sp. Gr.) =

$$\frac{53 + x}{57.61 + \frac{x}{5.35}}$$

Therefore $x = 54.9$ parts of zinc oxide necessary to fulfill the above conditions.

Volume Cost

From the same problem we may illustrate what is meant by volume cost in compounding. Filling in the costs and quantity of zinc oxide in our data we find that 107.9 pounds of this stock will cost today \$46.11, therefore, the cost of one pound will be \$.427. This stock has a specific gravity of 1.59, therefore, a cubic foot of it will weigh 62.4 (a cubic foot of water) times 1.59 or 99.216 pounds. We have already determined the cost per pound to be \$.427, therefore, the cost of a cubic foot or volume cost, as it is termed, will be \$.427 times 99.216 or \$42.36.

From the above example the method of compounding with reference to cost also will be illustrated.

If the volume cost must necessarily be low, then cheap rubber and pigments must be used. If on the other hand quality is not to be sacrificed to cost, then better materials may be employed. In this connection a compounder can save large sums of money for his company if he is able to produce a quality equal to or better than its competitor's at a lower volume cost. Experience here is a valuable asset.

A wide experience and knowledge of fillers and rubbers, with a clear understanding of what may be accomplished with each one, constitutes the requisite of a good compounder. Let us point out just a few of the many troubles that must be guarded against.

Troubles to Be Avoided

I. Some dirt may get into the compound, either through the fillers in their handling, or in the rubber itself, and as a result many dollars' worth of goods may be lost. This is especially true in the case of compounds which contain a high rubber content, like tubes or band stock. The rubber will not adhere to the dirt particles during vulcanization and when finished and the rubber is stretched it separates from the foreign body. This leaves a hole and weakens the goods at this point.

II. Moisture to any extent in any of the materials used in a stock is very objectionable. If moisture is present when the stock goes into the vulcanizers and is heated above the boiling point of water, this enclosed moisture will exist in the gaseous condition and cause "blowing" or the making of the stock porous. Again, it may come out toward the surface and there cause "blistering"; again, it may discolor white stocks; and, again, if present in fabric, it will cause poor unions in tire construction.

III. If the fillers contain any lead compounds or the batch pans from a previous stock, and these happen to find their way into what is supposed to be a white compound, they will discolor it.

IV. Great care must be exercised and close vigilance kept of what is going on in the compounding room. Should the wrong kind or the wrong amount of material be used or a certain material be left out of a compound, it will be liable to throw that stock out in cure, color and gravity, thus rendering it unfit for the purpose for which it was to be used.

V. Scorching on the mixing mills, calender or tube machines is usually due to forcing the stock to run faster than it should, too high temperature, too much speed or insufficient warming-up. Quick-curing stocks especially suffer from these causes. The best way to get them plastic so that they will run through other processes more easily is to work thoroughly on the mixing mills before any powders are added, or, in other words, be sure the rubber is well broken down.

VI. What is termed "tough stock" is generally caused from insufficient milling of the rubber before adding the fillers. Then, too, some compounds have a tendency to toughen on long standing. Some stocks may come off from the mill in good condition, but before the heat, caused in mixing, has had time to escape by radiation. The rubber will be piled in bins, thus trapping the heat, and there will ensue a certain degree of vulcanization. The result is similar to tough stock, but is really a scorched condition.

VII. A lumpy stock may be produced in several ways. For instance, the presence of dirt, as mentioned above, may cause it; or lumps which occur in shoddy which has not been evenly reclaimed or refined; then, too, the mixing of tough stock or scorched stock with a soft compound may be responsible.

VIII. Sulphur bloom on uncured stock, such as friction and cover stock, may be due to using tough or scorched stock, insufficiently "warmed up" stock, too high a temperature on the calender, and, under some conditions, too low a temperature.

IX. Poor union of stocks may be due to some incompatibility of the stocks to be joined, improper preparation of stock in mill rooms, dirt, moisture, soapstone, anything which may affect the tacky surface of the rubber, incompletely dried cement, or poor local workmanship.

X. Porosity of the cured stock may be due to mois-

ture as mentioned above, insufficient pressure, under cure, or improper compounding.

XI. Surface pitting is closely related to porosity or blowing, and is caused by air trapping, surface moisture, or perhaps the same causes which produce porosity.

XII. Improper cure is a thing which must be watched closely. If a sample is over-cured it cannot be brought back, for the process of vulcanization is not reversible. Over-cured stock may or may not lack in tensile strength, but it always lacks in stretch, is always short grain and ages very poorly. On the other hand, under-cured stock lacks in tensile strength, resiliency and generally in ageing properties. Therefore, the vulcanizing must be closely checked.

Delayed Activity in Popular Dyestuffs Education

The appearance of a 52-page, 9 x 11½ booklet attractively bound in boards entitled "World Disarmament and the Master Key Industry," issued by the American Dyes Institute, 130 W. 42nd St., New York. Wm. R. Corwine, Secretary, for the education of the public in the importance, from the standpoint of national self-sufficiency in peace and war, of a domestic dyestuff industry, directs attention to the advice of *CHEMICAL AGE* of almost a year ago, in commenting on the failure of the Congress to enact the Longworth bill. We said:

"The transfusion of political issues into an economic subject led to a partisanship wherein the superior vested interests dominated, to the sacrifice of the question of preparedness or the protection and encouragement of a superlatively important infant industry.

"The character-baiting and motive-perverting of political controversy always can be expected when a distinctly economic measure is subjected to the exigencies of a political theory.

"This experience of chemical financiers and dye manufacturers to procure from politicians a measure of protection consistent with all interests involved and with which the people are in sympathy, inculcates the lesson that they should have gone to the people with the problem in the first place.

Not only would they have got what the national instinct of self-preservation favors, but in the process an independent American dyestuffs industry would have been 'sold' to the American people."

This publication vividly sets forth the necessity, in this day of the application of chemistry to organized destruction, of the demolition of the monopoly of Germany in dyestuffs manufacture. It shows how this can be done by the encouragement and protection in each advanced manufacturing nation of a dyestuffs industry capable of serving with but little change the infinite needs of peace as well as the requirements of modern warfare.

The destruction of German dye-plants, surplus or otherwise, in any scheme of German disarmament, is advice of a character that indicates not only the intricacy of the problems that beset the treaty makers at Versailles but the shallowness of some of the thought brought to bear on the enterprise of applied science and the inability to "think it through."

J. W. McBurney has resigned as chemist of the Youngstown Sheet & Tube Co., Youngstown, Ohio, to become chief chemist of the Cleveland, Ohio, board of education at its school laboratories.

Future of Fine Chemical Manufacture in America

Absorption of Smaller Enterprises by the Larger Units in This Field Recommended

By Dr. Julius Stieglitz

Department of Chemistry, University of Chicago; Past President, American Chemical Society

THE immediate future represents a critical period for the manufacture of finer organic chemicals in this country. This is a matter of profound importance for our American people. Grievous as are our present economic ills, almost all of them will right themselves without permanent injury to the country as a whole. Our agriculture, our stronger established industries and commerce will return eventually to normal conditions. A few mushroom war industries may disappear without serious loss or injury to the country. But far-seeing men must ask themselves whether we as a nation can afford to risk the loss of the newer chemical industries, especially those concerned in the output of finer organic chemicals.

As has often been emphasized, our future preparation for defense in time of war, the safety of many of our larger industries consuming such chemicals, the health of our people, are all interwoven with this problem of chemical independence or self-containedness in the manufacture of a large proportion of the finer organic chemicals. These include the aniline dyes, synthetic medicinal remedies and hundreds of other finer chemicals required outright in the industries or as basic materials in the research work of our universities, Governmental laboratories and industrial research laboratories.

These investigations, let us remember, are the seed of the advances of to-morrow in science, industry, the safeguarding of health—advances to which we must contribute ourselves if we are not to be a dependent nation in these great fields of effort. The next years, indeed the next months, may decide whether we are going to revert to the dependence and helplessness of our pre-war state, for already importations from long established concerns in Europe are underbidding in many important instances our domestic manufacturers.

The future of our aniline dyes is industrially in strong hands and if Congress grants a measure of sane and far-seeing support, such as would be given by the passage of the Longworth bill, we may rest assured as to the success of our efforts to establish a permanent American dye industry. It will not be an easy contest by any means, but-granted anything like fair odds and time this industry will give a good account of itself.

It is a more dubious question whether our newer undertakings in the manufacture of synthetic drugs can survive the competition of long-established European concerns. On the whole our position is a very weak one, because the manufacture is scattered among too many smaller units. The actual bulk and value of individual drugs of this character required to satisfy the needs of the country is not so very large and distribution among smaller units means disproportionate



DR. JULIUS STIEGLITZ
Department of Chemistry, University of
Chicago; Past President, American
Chemical Society

overhead and manufacturing expense.

Even more doubtful, critical indeed, is the situation in regard to the hundreds of finer organic chemicals used as reagents, as intermediates or starting materials for manufacture and research. The manufacture of each chemical is a problem in itself, a problem of yields, methods, short-cuts, appliances which count in the cost. Because each chemical represents a problem, we find the actual manufacture of this type of organic chemical still more widely scattered than in the case of medicinals—among very many small and, economically speaking, expensive units.

Manufacturing a few hundred pounds of the substance X, sufficient to supply the market, does not warrant capital outlays for expensive appliances, vacuum stills, filter presses, mechanical mixers, etc. Hence much of the work involves laboratory instead of manufacturing methods, personal effort instead of machine work, at prohibitive cost compared with the cost in well-organized, well-equipped European establishments where not one but hundreds of these chemicals are

made and fine equipment and expert personnel can be used over and over again.

Consolidation Recommended

This brings me to the main conclusion and point of this plea for the survival of our manufacture of finer organic chemicals; our young men have actually solved problem after problem, have ventured and made good in the face of the difficulties, but unquestionably also because of the aid of war prices. It would not only be an economic waste, but in view of the vital importance of national chemical independence it would be to our shame to scrap what we now have.

We can compete if we use the same economies of method as are used abroad. We have solved the scientific difficulties. It is a question now of commercial readjustment to take advantage of the manufacturing facilities, the experience, the selling agencies of our larger established units.

Our stronger companies should therefore ask themselves whether it is not indeed worth their while to seek and take over now from successful individuals the manufacture of such chemicals, even though each individual chemical bulk small in volume and value. The smaller individual concerns engaged in synthetic drugs and other finer chemical manufacture should weigh most seriously whether it would not be the part of wisdom to seek an amicable arrangement for absorption by a large concern. At stake is American chemical independence and all it means. Wisdom and future results, not selfishness, must guide us now for the larger stake of the nation's future.

Overhead Expenses

How to Distribute Them in Good and Bad Times

By E. W. McCullough

Manager, Fabricated Production Department, Chamber of Commerce of the United States

A MANUFACTURING enterprise in its simplest terms consists of (1) a place to work, (2) machines to work with, (3) men to do the work, (4) material to work upon and (5) management to co-ordinate the whole.

A place to work requires maintenance. It must be repaired and cleaned, heated and lighted and watched. It bears taxes, rent and insurance and it also depreciates. Machines consume power and supplies, require insurance, attendance, repairs and cleaning and also depreciate. Men to do the work entail wages, liability insurance and supervision.

Materials include provision for receiving, sorting, handling and shipping. Delivery of material alone may demand a heavy investment in trucks and garage, teams, wagons, and stable, forming, in fact, a compact separate miniature organization.

Management takes care of the buying, selling, financing and administration, purchasing agents, salesmen, accountants, stenographers, stationery, postage, telephones, legal expenses, engineering, advertising, traveling, and so right down the line of what are known as general or commercial overhead expenses.

Such is your manufacturing enterprise in crude outline. Elaborate it, departmentalize, unify and combine it, as suits your own requirements.

Work—The Activities Involved

That which gives life and vitality to your manufacturing enterprise is *work*,—something to do. How *much* work you can turn out, what are the latent possibilities of your organization,—that is not often shown or demonstrated. Ordinarily your plant is idle sixteen hours out of twenty-four, and a day and one-half out of seven. Only in a great national crisis or emergency such as the recent war do we really speed up production and extract from our facilities the last ounce of usefulness.

Otherwise we strike a steady normal gait of healthy activity below the limit of what we can do, above the limit of slacking or lagging. This *norm*, this *mean* or *middle ground* of possible capacity, is an ever-present fact in industry. It is *there* and should be recognized as a starting point in the discussion and treatment of industrial problems such as costs. Normal capacity is your "100" mark, above which your organization registers in times of excessive or unusual activity, below which it drops in times of curtailed production and demand.

No Work—Operations Cease, But Do Expenses?

The even flow of work is subject to many interruptions. There are strikes and transportation tie-ups, machinery breakdowns, seasonal fluctuations and years of light demand, such as we are at present experiencing. What happens when there is no work or little work? Do the expenses incident to running a business cease or recede accordingly? Your building still carries its taxes, rent and insurance, and needs about the same degree of repairing, heat, light and watching, and meanwhile it depreciates. Likewise your equipment continues to depreciate and requires insurance and some maintenance. Theoretically you can discharge your men, but practically you find odds and ends of work, nonpro-

ductive tasks, for the best of them, and of course you retain your superintendents and many of the foremen. You stop feeding the equipment *materials*, but your money is still tied up, and the material deteriorates, and must be insured, properly stored and cared for. When it comes to the management, you cannot sacrifice your executives, your office, your best salesmen, your best chemists and engineers, accountants or clerks. Such are the considerable expenses incident to not doing business; expenses which go on for a considerable time whether or not you are doing a dollar's worth of business or work, expenses that must go on if the organization is to remain intact.

The Consumer Pays

Since such interruptions of industry are still an ordinary incident of business, and carry a cost that must be reckoned, the business man hopes the consumer will pay for them. Where facilities are based and attuned to the needs of the market, and are not a war-time mushroom growth, the demand of the business man does not appear unreasonable. The trouble very often is that his cost system does not show him how he can recoup such losses.

When the very considerable expenses of not doing business are applied in full to a reduced activity, very high costs result—costs out of all relation to the true costs of production, and costs bearing no relation to what the market will bring. In such time two opposite tendencies develop.

On the one hand the business man who is a firm believer in his cost system refuses to take business except on a basis of his inflated costs and thereby further restricts business at a time when the crying need is for more and not less business. The more skeptical business man feels there is something wrong with his cost system, proceeds to ignore it and sells his product for whatever he can get. This treatment of the cost system is more largely responsible for demoralized markets and prices than is realized. Meanwhile the plant is bearing the full brunt of slackened activity.

A Normal Year—The Business Standard

Our cost systems are far too rigid. Under cost methods still largely in use overhead expenses are spread too thin in times of forced production and, massed too heavily in periods of slight demand and production, giving in the former case costs that are artificially low and unfair to the management, and in the latter case costs that are artificially high and unfair to the public, and moreover costs which the market will not sustain.

For the sake of convenience, we split up our business into years and treat each year as though it were separate, distinct and unrelated, whereas no such sharp cleavage exists. Year merges and glides into year, one dependent upon and connected with the other. The injustice and inaccuracy of a complete and abrupt cut-off is clearly illustrated by an income tax law which heavily taxes the profit of one year, and makes no compensating allowances for the losses of the following or preceding year's operations.

Cost systems should recognize this continuity of time wherein any single year or month *may* or *may not* typify and represent normal production and demand. There are expenses, it has been shown, which continue whether

the plant is idle or in operation, expenses that, moreover, bear no direct relation to output.

Cost systems should provide that these expenses, usually designated as overhead expenses, should be absorbed and pro-rated on the basis of a *normal year*. Thus in time of unusual production the overhead should be more than used up in costs, and a surplus out of overhead cost created to take care of those years when the output is below normal and the overhead charges not fully absorbed in the costs of that year.

To take a very simple illustration: Let us assume the normal output of a department is 100 pieces and the overhead \$100, or an overhead charge of \$1 per item. If the department produces 150 pieces at a normal overhead charge of \$1 per item, not only will the \$100 overhead be used up but there will be an additional \$50 as a reserve accruing to the management. When the output of the department drops to 50 pieces, only \$50 overhead will be applied to this reduced production, and the difference made up from the reserve established during unusual production. This method of cost procedure has numerous advantages, two of which should be emphasized.

(1) It will assure the business man a reward for his efforts in speeding up.

(2) It will eliminate the needless throttling of business by the impractical attempt to load semi-normal production with greater charges than can or should be borne.

Operation Under a Normal Year Basis

Determining a normal year requires a long look behind and a far look ahead. It is by no means sufficient to accept the operations of the preceding year as the sole standard. The normal year is different for a new organization or industry from what it is for one long established. The normal year does not remain on a dead level, but should probably curve upward gradually and conservatively with the growth of population and markets. To do otherwise would indicate industrial stagnation.

To establish normal unit overhead charges, two things must be determined, viz., (1) normal overhead expenses for the various departments of the business; (2) normal production. When the normal overhead expenses are divided by the normal production the result is the normal unit overhead charge.

In determining normal overhead expenses, those expenses of the previous years which are accidental should be eliminated. An effort must also be made reasonably to anticipate and allow for the trend of expenses for the coming year.

But there is nothing conclusive, final or binding about this estimate of normal expenses. Each month your cost system gives the estimated overhead expenses and the actual expenses. If there is an increase of the actual over the estimated, and upon analysis that increase is found to be a real increase, due to unanticipated increase of salaries or insurance rates, etc., and not an inflation arising from reduced production, an adjustment upward can immediately be made in the unit overhead charges. Each concern will establish for itself a safety zone, below or above which decreases or increases in real costs will be reflected and taken up in the selling price.

In determining normal production due allowance must be made for interruptions of operation. Even in the *job* industries, which by necessity have been schooled to base overhead charges on a normal year, the tendency is still to base capacity on regularly operated machines. When these machines do not regularly operate, it is apt

to go hard with the establishment. In a paper mill with a possible yearly operating time of 7,488 hours, the plant was idle 689 hours or not quite 10 per cent. of the time, because of the usual and customary interruptions from changing wires and felts, starting and stopping, repairs and high water.

How transportation tie-ups, strikes, and slackened demand in many industries affect production is, of course, familiar to all. In determining normal production, then do not delude yourself by placing it too high—at a mark reached only in exceptionally fortunate years.

Necessary Cost System Adjustments

Though cost accountants and industrial engineers are prone to using strange and technical terms for it, the accounting device used to secure operation on a basis of a normal year is the now familiar one of the Reserve, or a modification thereof.

For purposes of illustration, let us recall how a simple reserve, such as the reserve for bad debts, operates. The operating account "bad debts" is debited each month with the estimated amount of bad debts likely to be sustained, and the account "reserve for bad debts" credited each month with a like amount. As bad debts are actually sustained, the amount thereof is debited to the Reserve for Bad Debts. It is very easy to ascertain for income tax purposes the amount of bad debts actually sustained during the year by referring to the debit side of the Reserve for Bad Debts, and ascertaining the estimated allowance for bad debts by referring to the credit side of the Reserve for Bad Debts.

So the estimated normal overhead expenses will be charged into costs upon the particular cost method employed (man-hours, machine-hours, productive labor, etc.) and likewise credited to the Reserve for Overhead. The actual overhead expense will be debited to the particular expense accounts, and closed out periodically to the Reserve for Overhead. Accordingly, the debit side of the Reserve for Overhead will give the actual expense totals, and the credit side the estimated expense. It is assumed such a reserve for overhead will be subdivided in accordance with departmental requirements, and where convenient the expenses will be scheduled.

The proceeding has, moreover, left out of consideration refinements recommended by cost accountants of the principle of the Overhead Reserve, such as Under and Over-Earned Overhead or Burden, Overhead or Burden Variance, Supplemental Rates, etc. These do not disturb the essential principles set forth and are apt to confuse a simple presentation of them.

Some Misunderstandings Clarified

Certain misunderstandings arise concerning the distribution of overhead expenses on the basis of normal year which should be mentioned and disposed of.

1. *The setting up of estimated overhead charges based on a normal year does not mean the abandonment or compromising of actual overhead costs.*

The actual expense exists alongside of the estimated and one is compared with the other and differences analyzed and accounted for. To an executive such an analysis reveals the story (1) of inefficiencies that must be eliminated, (2) of advances or decreases in costs not anticipated, and (3) of costs artificially low or high because of sub- or abnormal production.

A cost system must furnish information that will guide and temper the entire policies of an enterprise. At a time when more and not less business is needed, a cost system that literally interpreted instructs an executive to refuse business except on prohibitively high and inflated costs of production falls down when most

needed. Such a system, though arithmetically correct, presents results that are misleading and which may work serious injury. Accordingly, the actual overhead charges are checked, corrected, supplemented and eased by the estimate of expenses based on the normal year.

It is not the intention to let a single dollar of overhead expense that is not accurately and fairly charged to operation, sales or administration.

That the management should bear the expense of sub-normal production is a point that has been stressed altogether too exclusively. Meanwhile not sufficient emphasis is given to the converse, viz., that the management should be rewarded for abnormal production. One is as fair as the other.

The balance in the Reserve for Bad Debts is not customarily closed out to Profit and Loss at the end of the year, but carried forward into the next year's operations, since any one year may or may not be typical of the bad debts normally sustained. So likewise the production of any one year may or may not be normal, and the balance of the Reserve for Overhead, be it debit or credit, should accordingly be carried forward. If the estimate of normal capacity is reasonably low and cautious, such overhead expenses as have not been absorbed in one year will be absorbed and the losses recouped in the years of exceptional production, for in the long run the depth of the depressions will very nearly equal the height of the peaks.

Found Feasible in Practice

What has been stated is elementary and suggestive. Its aim is to stimulate interest and encourage such changes as are necessary to meet progressive competition. The subject has been brewing for some time. It is referred to in the pamphlet of the Federal Trade Commission, "Fundamentals of a Cost System for Manufacturers," published in 1916, and to its development numerous well-known cost accountants and engineers have contributed. Upon inquiry of the Fabricated Production Department, establishments in such widely separated industries as paper, cutlery, envelopes, stove, and metal products are operating on the basis of a normal year and upon this basis distributing overhead.

It will be useful to quote from the practice of one producer.

Our whole cost scheme consists in the first place of a budget, made up the first of each year, for every department, machine and production center. This budget must naturally be based upon past experience plus an intelligent estimate of the possibilities for the year. The hours of operation, or the production units, are arrived at by taking an assumed 80 per cent. of possible operating time as a basis. In all these industries the standard week consists of forty-eight hours, or an eight hour day. Deducting Sundays and holidays we assume that the year consists of three hundred working days of eight hours each, or 2,400 hours. We take 80 per cent. of this, or 1,920 hours, as our normal unit. This figure used in connection with our budget of expense and operation gives us our normal rate.

We use this normal rate at all times in figuring both estimates and costs. Last year most manufacturers operated more than this normal, with a result that their actual costs were less than the normal cost, and this gain was taken as a sundry profit.

At the present time the costs are running considerably higher than the normal, and for some time at least we must absorb this loss, maintaining at the same time a standard normal rate, but not subject to the violent fluctuations brought about by any increases or decreases in the volume of business handled.

But the number and percentage of establishments so operating is indeed inconsiderable and to many the mere idea of distributing overhead on a basis of a normal year is novel and daring.

Conclusion

The treatment of overhead in the way indicated is not

a panacea for all our industrial ills. The control of overhead in a manner fair to the business man as well as the consumer is one step and only one step toward realizing more stable prices and eliminating those wild fluctuations that culminate in industrial depressions. Such a consideration also points out this moral, viz., that the hope of permanent reduction of costs rests only in the greater, more continuous and more regular use and operation of our industrial facilities.

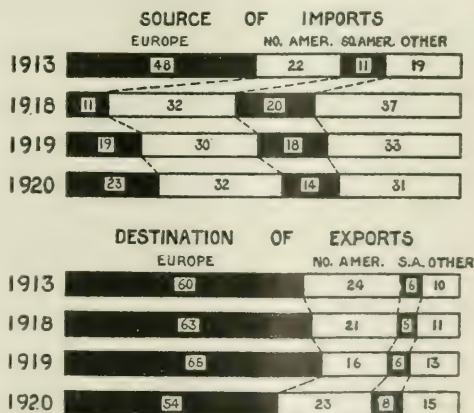
Thousands of firms went through the recent years of full-blast operation upon a basis of overhead distribution essentially unfair to them. A start in the right direction must be made, and upon such firms is urged the consideration of adjusting overhead charges on the basis of a normal year, and it is so suggested, both as an advance in sound cost accounting and as a measure to facilitate that business revival we all desire, need and anticipate.

Direction of Foreign Trade

The diagram below brings into comparison the direction of the foreign trade of this country during the past three years and in 1913. It is shown that an important change has occurred in the sources of imports, but that there has been comparatively little variation in the direction of exports.

In 1913, 48 per cent. of our import trade came from Europe, but notwithstanding the large increase of imports from this division, Europe now ranks third in her sales to us, due to her economic exhaustion. It is also attributable to the development of production in China and Japan, nearly half our Asiatic imports coming from those two countries, where the minimum wage scale of the world is in effect.

Ninety per cent. of the North American imports came from Canada, Cuba and Mexico—612, 721 and 180 millions of dollars' worth, respectively. It is interesting to note that we imported \$89,000,000 worth of goods from Germany during 1920, compared with \$11,000,000 worth the previous year, indicating the commercial come-back which that country is staging. Our normal imports from Germany before the war were about \$180,000,000.



Comparison of the Europe black area in the above diagram for the years 1913 and 1920 visualizes the growth of our purchases from that continent that approximately will be necessary to the restoration of normal exchange and the rehabilitation of her productive capacity.

Nitrogen Fixation in Germany

The U. S. Department of Commerce in Berlin, Germany, reports under date of January 10, 1921, on the present situation in Germany as to the production of nitrogen fertilizers by fixation of atmospheric nitrogen:

Calcium cyanamide factories engaged in the production of nitrogen fertilizers by process of fixation of atmospheric nitrogen were in operation in Germany before the war, but during the war these plants were extensively enlarged and are now in process of completion. The total output of these plants when properly supplied with coal is estimated at 600,000 tons, with a nitrogen content of 120,000 tons. Several plants representing this production, together with the possible output of each are as follows:

	Tons
Mitteldeutsche Stickstoffwerke A. G. Piesteritz...	175,000
Oberschlesische Stickstoffwerke A. G. Chorzow...	150,000
Aktiengesellschaft für Stickstoffdünger, Knapsack, Gross Kayna	140,000
Bayerische Stickstoffwerke A. G., Trostberg and Margarethenberg	75,000
Lonzawerke, Waldshut	60,000
Total	600,000

At the present time these plants are producing approximately 500,000 tons of calcium cyanamide, with a nitrogen content of 100,000 tons.

Prior to the war the production of nitrogen fertilizers by coke and gas industries reached a figure of 580,000 tons, with a nitrogen content of 116,000 tons. However, the coal shortage has militated against the maintenance of production at these figures.

The Badische Anilin und Sodafabrik is the only concern producing nitrogen fertilizers by the Haber-Bosch process. Its first factory for this purpose was constructed at Oppau. Operations began at this plant in 1913. A second plant known as the Ammonia Works of Merseburg, which is twice the size of the Oppau plant, was later erected, and has been in operation since 1917. When properly supplied with raw material, the annual output of nitrogen in both of these plants is 300,000 tons, corresponding to 1,500,000 tons of sulphate of ammonia.

Before the war Germany's annual agricultural requirements of nitrogen fertilizers were 210,000 tons of nitrogen, of which 100,000 tons were in the form of nitrate of soda and nitrate of lime (imported), 100,000 tons in the form of sulphate of ammonia from home production, and 10,000 tons in the form of calcium cyanamide, likewise of home production. At the outbreak of the war there were only 40,000 tons of nitrate of soda within the country, which were immediately taken for the manufacture of ammunition. The total production of nitrogen fertilizers by the plants now existing, and those in process of construction, will approximate 500,000 tons of nitrogen, equal to more than twice the amount required for agricultural purposes before the war.

In spite of their high cost, nitrogen fertilizers are in great demand in Germany today. A quantity of sulphate of ammonia containing one kilo of nitrogen cost 1.35 marks in 1913, as against 12 marks in 1920. At the same time, 100 kilos of ammonia fertilizer with 20 per cent. nitrogen, cost 27 marks in 1913 as against 240 marks in 1920.

Julius Credo, formerly superintendent of the Hildick Apple Juice Company, Mt. Kisco, N. Y., is now with the Louisville Drying Machinery Company, Louisville, Ky.

Cotton Linters for Paper Making

The high prices prevailing until recently for paper pulp which were reflected in the cost of all paper materials and the use of cotton linters for the manufacture of the main ingredient of smokeless powder, gave to a former low-value by-product of cotton-seed an economic importance theretofore unknown.

The length of the linter fibre is determined by the set of the delinter knives in oil-mill practice whereby a long or short fibre may be obtained. The chief pre-war outlet of the delint was for upholstery purposes, where the quality was unsuited for spinning. War-time demand for linters for munitions resulted in an increase in the yield per ton of cotton-seed from 65 lbs. to almost 200 lbs. The Armistice found over a million bales of this material on the Government's hands, the disposition of which was a perplexing problem until experiments by the Forest Products Laboratory demonstrated its suitability for bond paper manufacture when mixed with sulphite stock.

Cotton oil millers in seeking the line of least resistance in the marketing of a product whose highly remunerative outlet cessation of the war had closed, found it easier to manufacture bleached linter pulp than to induce the writing-paper manufacturer to instal equipment to pulp raw linters. In addition to the enterprise of the Stamscott Co., Inc., at Hopewell, Va., which is backed by cotton oil interests, and independent enterprise at Nitro, W. Va., in the manufacture of cotton linter pulp, other plants have been established in the cotton growing districts for the utilization of linters in pulp manufacture.

The development of this enterprise in the agricultural south is noteworthy as an addition to its industrial activity especially since it connotes the establishment of allied enterprise under the influence of accessibility to raw material and markets.

The most satisfactory outlet for long-fibre delint is in writing-paper manufacture as a substitute for rag-stock in admixture with sulphite. The manufacture of building papers such as sheathing and for use in prepared roofing and shingles will provide an outlet for the inferior delint more or less contaminated with seed-hulls. Fibre board manufacture will provide an additional outlet.

The total production of magnesite in the United States in 1920 was 303,767 short tons, which was valued at approximately \$2,748,150, an increase of 94% in quantity over that of 1919. The entire output was made by two states, California and Washington. California mined 63% more magnesite in 1920 than in 1919 and more than eight times as much as it mined seven years ago. Washington increased its production 109% over that the preceding year, making by far the largest output it has yet made.

* * *

The Hercules Powder Company in its annual report for the year ended December 31, 1920, shows net earnings, after charges and taxes, of \$492,250, equivalent after preferred dividends to \$1.02 a share on the \$7,150,000 common stock, as compared with net of \$1,579,794, or \$16.85 a share, in 1919. In 1918 net income amounted to \$2,315,000, while in 1917 the profits amounted to more than \$5,800,000.

The completion of plans long under way to acquire the assets of the Aetna Explosives Co., Inc., await the sanction of the U. S. Circuit Court of Appeals. The Hercules Powder Co. plans to form a new subsidiary corporation in New York, to which the assets of the Aetna Co. will be transferred.

Decennial Celebration at the Chemists' Club

Four distinguished American chemists and four foreign ones on March 17 received the Honorary Membership from the Chemists' Club at the tenth anniversary of the opening of its present home at No. 52 East 41st Street, New York.

Owing to the international aspect of the occasion, representatives of the embassies of Great Britain, Belgium, France and Italy were present. The foreign chemists who received the honor of membership were:

Dr. Giacomo Ciamician, professor of general chemistry at the University of Bologna, Italy, who for more than 42 years has been making a special study of the influence of sunlight upon plants and animals, and is an ingenious and original investigator in pure organic chemistry.

Dr. Henri Louis LeChatelier, professor at the College de France and at L'Ecole des Mines, whose studies of chemical action and heat have greatly influenced metallurgy and applied chemistry.

Dr. Ernest Solvay, of Brussels, Belgium, founder of the ammonia-soda process.

Sir Edward Thorpe, professor of chemistry emeritus of the Imperial College of Science and Technology, South Kensington, England; former director of the Government Laboratories in London, and editor of "Thorpe's Dictionary of Applied Chemistry."

The Americans inducted into Honorary Membership were:

Dr. John Uri Lloyd, of Cincinnati, Ohio, Past President of the American Pharmaceutical Association and also well known in general literature through such works as "Stringtown on the Pike," and similar studies of the blue grass country.

Dr. William Henry Nichols, of New York City, Past President of the American Chemical Society, the Society of Chemical Industry and the Eighth International Congress of Applied Chemistry, and noted as a chemical industrialist.

Dr. Edgar Fahs Smith, of Philadelphia, President of the American Chemical Society, until recently Provost of the University of Pennsylvania; a distinguished investigator in electrochemistry, also the historian of American chemistry.

Dr. Edward Weston, of Newark, N. J., inventor of electrical appliances and of incandescent lamps and filaments.

A reception was held in the Social Room which was followed by a dinner, after which the members and their guests adjourned to the auditorium of the Club, Rumford Hall, where the formal ceremony of conferring honorary membership was held. Addresses were delivered by Dr. Irving Langmuir, of the Research Department of the General Electric Company of Schenectady, New York, and by Dr. Jacques Loeb, of the Rockefeller Institute.

The president of the Chemists' Club is Elwood Hendrick, and the secretary, J. R. M. Klotz. The chairman of the committee having charge of the celebration was Professor Charles Baskerville, of the College of the City of New York.

J. G. Braun, a chemist of San Antonio, Texas, announces the discovery near Floresville, Texas, of alunite deposits, portions of which surpass in quality any yet found in the United States.

Derivatives of alunite are potassium sulphate, aluminum sulphate, aluminum oxide, ultramarine and all other salts of potassium and aluminum.

Supervision of Mineral Production from Government Lands

The Federal Leasing Act of Feb. 25, 1920, known as "an act to promote the mining of coal, phosphate, oil, oil shale, gas and sodium on the public domain," has been placed by the Secretary of the Interior under the direction of the Bureau of Mines, which with an allotment of \$60,000 properly to organize and carry on the work until July 1, 1921, is now in a position more adequately to assume its responsibilities.

Present annual petroleum production of 14 million barrels from government lands in California and Wyoming, with prospecting permits for drilling in 11 other states and Alaska, indicates the extent of production supervision now required.

F. B. Tough, petroleum technologist of the Bureau of Mines, has been made supervisor of oil and gas operations, with headquarters in the Custom House Building at Denver, Col., and will report direct to the Chief Petroleum Technologist in Washington. District engineers and deputy supervisors, together with oil gaugers and clerks, have been placed at Casper, Wyo.; Winnett, Mont.; Bakerfield, Cal., and Shreveport, La., reporting to the supervisor at Denver.

Leases dealing with coal, phosphate, oil shale and sodium compounds as they involve mining operations, both underground and surface, are under the immediate technical charge of George S. Rice, chief mining engineer of the Bureau of Mines. At the present time the principal mining operations are in coal, although leases have been applied for covering the other mentioned minerals. This part of the work will be handled in the field for the present by a District Mining Supervisor, with offices in the Custom House Building at Denver.

The Wet-Milling of Corn

The manufacture of starch, dextrose, syrup (glucose) and dextrose from corn in the United States consumes 200,000 bushels of shelled corn per day (70 million bushels per annum) and yields as by-products edible and industrial oil (germ) and cattle feed (concentrated solubles, hulls and press-cake).

The 65 million bushels of corn used by the industry in 1919 yielded 1 1-2 billion pounds of unmixed glucose, 800 million pounds of starch, 125 million pounds of corn sugar, 95 million pounds of oil, 450,000 tons of gluten feed and 45,000 tons of oil-cake and meal. Thirty per cent. of the 750,000 tons of candy produced yearly in America is glucose used to improve its taste and texture as well as to displace sucrose or non-inverted sugar.

The following concerns comprise the American industry of the wet-milling of corn:

American Maize Products Co., 1 factory at Roby, Ind.
Clinton Corn Syrup Refining Co., 1 factory at Clinton, Ia.
Corn Products Refining Co., factories at Argo, Ill.; Pekin, Ill.; Edgewater, N. J. and Kansas City, Mo. (under construction).

J. C. Hubinger Bros. Co., 1 factory at Keokuk, Ia.
Huron Milling Co., 1 factory at Harbor Beach, Mich.
Keefer Starch Co., 1 factory at Columbus, Ohio.
National Starch Co., 1 factory at Oswego, N. Y.
Penick & Ford (Ltd.), 1 factory at Cedar Rapids, Ia.
Piel Bros Starch Co., 1 factory at Indianapolis, Ind.
Tentor Corn & Fruit Products Co., 1 factory at Granite City, Ill.

Union Starch & Refining Co., 1 factory at Edinburg, Ind.
A. E. Staley Manufacturing Co., 1 factory at Decatur, Ill.

Compania Sud Americana de Cereales, a Dutch corporation, has under construction at Rosario, Argentina, what is reported will be the largest linseed oil mill in the world.

American Graphite Industry in 1920

THE quantity of domestic flake and amorphous graphite sold by producers in the United States in 1920 amounted to 9,510 short tons, an increase of 28 per cent. over the quantity sold in 1919.

The value of the graphite sold in 1920 was about \$626,201, as compared with \$778,857 in 1919. These figures are based on reports made by producers to the U. S. Geological Survey, Department of the Interior.

Operators in Colorado, Nevada, and Rhode Island reported sales of 4,694 short tons of amorphous graphite in 1920 at an average price of \$10.60 a ton. This was \$3.52 per ton less than the average price in 1919.

The sales of crystalline graphite in 1920 amounted to 9,632,360 pounds, valued at \$576,443, as compared with 8,086,191 pounds, valued at \$731,141 in 1919. The average price per pound in 1920 was 5.9 cents; in 1919 it was 9 cents. Alabama led in the production of crystalline graphite, the sales in 1920 amounting to 4,894,648 pounds, or 51 per cent of the total quantity sold in the United States.

The sales reported from New York and Pennsylvania amounted to 3,552,687 pounds, or 37 per cent. of the total in the United States and the remaining 13 per cent. was reported from California, Montana and Texas.

The Acheson Graphite Co. reported the sale of 7,399,749 pounds of artificial graphite, which it manufactured at its plant at Niagara Falls, N. Y.

Domestic Graphite Sold in 1915-1920.

Domestic Graphite Sold in 1915-1920						
(Short tons)						
Year	Amorphous		Crystalline		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1915	1,181	\$12,358	3,557	\$417,273	4,718	\$429,631
1916	2,622	20,723	5,466	914,748	8,088	935,471
1917	8,301	73,481	5,292	1,094,398	13,593	1,167,879
1918	6,560	69,455	6,431	1,454,799	12,991	1,524,254
1919	3,379	47,716	4,043	791,141	7,422	1,080,000
1920	4,694	49,758	4,816	576,443	9,510	626,201

Graphite manufactured by the Acheson Graphite Co., 1915-1920.

Year	Pounds	Value
1915	5,084,000	.....
1916	8,397,281	.....
1917	10,474,649	.....
1918	9,182,272	.....
1919	8,163,177	.....
1920	7,397,749	.....

Graphite imported into the United States in 1920.¹

Country of origin	Quantity (short tons)	Value
Ceylon	9,204	\$1,077,290
Madagascar	4,710	286,383
Canada	2,170	157,015
Brazil	.....	.....
Mexico	3,659	131,832
Chosen (Korea)	810	29,936
Italy	137	5,072
Austria	58	1,195
Germany	30	2,502
Other countries	317	20,987

21,095 \$1,711,312

¹These figures are preliminary and subject to revision by the Geological Survey.

The United States Civil Service Commission announces an open competitive examination to be held April 13 to get eligibles for the position of junior wharf examiner of food and drugs. Vacancies or duty in the field at \$1,200 a year and in positions requiring similar qualifications, at this or higher or lower salaries, will be filled from this examination, unless it is found in the interest of the service to fill any vacancy by reinstatement, transfer or promotion. Appointees whose services are satisfactory may be allowed the increase granted by Congress of \$20 a month.

Petroleum Section of American Chemical Society

The organization of a Petroleum Section has been authorized by the officers of the American Chemical Society. It is proposed to hold the initial meeting of this section at the general meeting of the society at Rochester, April 26-29, for which occasion Dr. Thomas G. Delbridge, Atlantic Refining Co., Philadelphia, has been appointed chairman and Dr. W. A. Gruse, Mellon Institute, Pittsburgh, secretary.

The purposes which this organization is expected to fulfill may be expressed as follows:

I To enable chemists and technologists engaged in the petroleum, shale-oil and natural gas industries to meet and to correspond and to accumulate trustworthy information regarding the geochemistry of petroleum, oil-shale and natural gas, the conversion of the raw materials into manufactured products, and the characteristics and usages of these products, together with their transport and storage.

II To promote the better education of persons desirous of becoming petroleum engineers, refinery engineers or hydrocarbon chemists, and to elevate the professional status of those employed in the industries mentioned by establishing a high standard of scientific and practical proficiency.

III To encourage inorganic hydrocarbon chemistry.

IV To co-operate with the American Petroleum Institute and with the National Research Council, and to collaborate with the American Society for Testing Materials in its work on the standardization of bituminous and petroleum products.

Fifty chemists and chemical engineers actively engaged in the petroleum industry have pledged their support and co-operation; fifteen papers on the chemistry of petroleum have been promised for the first meeting. At this meeting it is desired also to take up such questions as that of the degree and scope of the activities of the section, the form of co-operation with other technical and scientific societies, the exact name of the section, and other interesting points. If time permits it is planned to hold an informal symposium on the problems of petroleum and allied industries.

All persons who desire to become members of the section are requested to send their names to Dr. W. A. Gruse, Mellon Institute, Pittsburgh, Pa. A full attendance at this organization meeting is urged and the submission of papers is solicited.

Portland cement output in 1920 aggregated 100,302,000 barrels produced by 115 plants, an increase of 4 over the preceding year and with an increase of 24 per cent. in production in the same period.

* * *

The Department of Agriculture, in the exercise of its retained war-time powers over the sale of fertilizers, sought, by negotiations between phosphate producers and farm organization purchasing agents, to bring about lower prices for fertilizers. It is charged that several of the fertilizer companies either own directly or control through subsidiary and interlocking companies phosphate mines. These fertilizer operators have claimed the right to charge prevailing prices on the ground that the cost of rock phosphate has greatly increased. The farmers charge that these companies are in reality the owners of the phosphate in question and are holding up prices by means of interlocking directorates.

Personal Items

Leo Roon, chemical engineer, has severed his connection with E. R. Squibb & Sons, Brooklyn, N. Y., to engage in consulting practice at 253 Broadway, New York.

* * *

W. E. Weinz, formerly with the Boston office of the Grasselli Chemical Co., has been appointed general manager of the Chicago office.

* *

Dr. E. A. Ruddiman, formerly Dean of the School of Pharmacy, Vanderbilt University, Nashville, Tenn., is now director of research for the John T. Milliken & Co., St. Louis, Mo.

* * *

C. R. DeLong has been made director of the chemical section of the Tariff Commission. Dr. Grinnell Jones, of Harvard University, who formerly held the position, has been retained in an advisory capacity.

* * *

William Wrigley, Jr., Chicago, Ill., has been elected chairman of the board of the Gunnison Valley Sugar Co. of Utah. Mr. Wrigley's enterprises are said to represent the second largest consumption outlet for sugar in the world.

* * *

Dr. R. F. Rutnan, head of the department of chemistry at McGill University, has been appointed administrative chairman of the Honorary Advisory Council for Scientific and Industrial Research in the absence of Dr. A. B. Macallum in the Orient.

* * *

Dr. J. C. Witt has been placed in charge of chemical research for the Portland Cement Association. This work is being carried on at the Structural Materials Research Laboratory, in cooperation with Lewis Institute, Chicago.

* * *

Cedric B. Smith has resigned as editor and manager of *Professional Engineer*, published by the American Association of Engineers, to accept a position with the Chicago Bridge and Iron Works of Chicago. He is succeeded by C. R. Thomas, in charge of the publication of results, Forest Products Laboratory, Madison, Wis.

* * *

Arthur E. Rice, for many years identified with the Pennsylvania Salt Mfg. Co., Phila., Pa., as vice president and treasurer, has been elected president to succeed Joseph Moore, Jr., deceased. E. E. Armstrong, who has been general superintendent, was elected vice president and general manager of works.

* * *

W. M. Boyle, formerly manager of the du Pont high explosives plant at Ramsay, Montana, has been appointed general manager of the Compania de Explosivos de Chili. J. H. Wellford, formerly assistant manager of the Barksdale, Colorado, plant, succeeds Mr. Boyle as manager of the Ramsay plant.

* * *

James R. Emmett, long connected with the Boston office of the National Aniline & Chemical Co., has associated himself with Arthur L. Norton, formerly of the same organization, and with Justin Edwards, well known in dyestuffs and textile lines, as the Special Products Co., 261 Franklin St., Boston, Mass., dealers in dyestuffs and textile and tanners' specialties.

C. K. Jones, formerly with the Van Camp Packing Co., Indianapolis, Ind., is now chief chemist of The Whitman Candy Co., Philadelphia, Pa.

* * *

Dr. J. A. Bridgman, formerly research chemist in the Jackson laboratory of E. I. du Pont de Nemours & Co., is now in charge of production for the Wilbur White Chemical Co., Owego, N. Y.

* * *

Joseph B. Oesch, formerly chief chemist of British Dyes, Ltd., is now chief research chemist of the Newport Co., Carrollville, Wis.

* * *

Dr. Milo C. Burt, formerly of the Aetna Explosives Co., and Walter R. Hibbard, formerly of the Remington Arms Co., Inc., have opened a consulting laboratory in Bridgeport, Conn., as Burt & Hibbard, Inc.

* * *

C. E. Adams, vice-president of the Air Reduction Co., 120 Broadway, New York, has been appointed president to succeed A. F. Blagden, now associated with the American Dyewood Co. and affiliated interests.

* * *

A. Klipstein & Co., 654 Greenwich Street, New York, has been appointed selling agent in the United States for the products of the British Alizarine Company of London and Manchester.

* * *

Dr. Carl Alsberg, Chief, Bureau of Chemistry, Department of Agriculture, has been appointed director of the Food Research Institute, the establishment of which by the Carnegie Corporation at the Leland Stanford Junior University, Palo Alto, Calif., is noted elsewhere in this issue.

* * *

The profits derived from the sale of arsphenamine, amounting to \$500,000, made during the war as result of experiments conducted in the Dermatological Research Laboratories of Philadelphia by Dr. Frank Schamberg, director, and his two assistants, Dr. Kolmer, professor of Pathology and Bacteriology, and George M. Raiziss, professor of Chemotherapy, of the Graduate School of Medicine of the University of Pennsylvania, have been given to the Laboratories by these gentlemen for the support of medical research.

* * *

Dr. William H. Jordan, a pioneer in agricultural chemistry and its applications, has retired from the directorship of the New York Agricultural Experiment Station, at Geneva, New York, after many years of faithful public service. A contemporary encomium of Dr. Jordan's work says: "As a pioneer in agricultural chemistry Dr. Jordan has given us a foundation for much agricultural science and practice, for sound agricultural legislation, and for future agricultural research. He helped to plan the oldest field experiments in fertilizers on this continent. He has secured, or helped to secure, the facts on which much fertilizer, food, and feed legislation is based. He has added to the list of varieties of useful products and to the incomes of those who grow them. It is fitting that the achievements of such men should be recognized. This not alone for their sakes, but for the cause of research which is not adequately understood or provided for in the present scheme of agricultural development."

Industrial Notes

The Pennsylvania Coal Products Co., Pittsburgh, Pa., will engage in the manufacture of resorcinol.

* * *

United States Industrial Chemical Co. will enlarge its Curtis Bay, Md., plant by a 60 x 180 ft. addition at Stonehouse Cove.

* * *

The Union Sulphur Co., 17 Battery Place, New York, has purchased a 7-acre tract at tidewater on Kill von Kull in the Bergen Point section of Bayonne, N. J., on which it will erect a warehouse.

* * *

American Wood Chemical Company has been incorporated in Delaware with a capital of \$800,000. Incorporators: C. H. Blaskie, Wilmington; R. L. Frost and John S. Wrinkler, Chattanooga, Tenn.

* * *

The Glidden Co., paint and varnish manufacturers, headquarters, Cleveland, Ohio, is the latest accession to the artificial butter industry. The Glidden Nut Butter Co., Chicago, Ill., represents the enterprise of the organization in this field.

* * *

The Nashville Industrial Corporation, that acquired from the government the Old Hickory smokeless powder plant near Nashville, Tenn., has appointed Meigs, Bassett & Slaughter, Inc., chemical engineers, 210 South 13th Street, Philadelphia, the consulting chemical engineers in the work of transformation of this colossal enterprise to peace-time uses.

* * *

A special meeting of the stockholders of the Celluloid Company has been called for March 17 to vote on amending the certificate of incorporation by increasing the authorized capital stock of the company from \$6,000,000 to \$10,098,000 par value, to consist of \$3,000,000 8 per cent. cumulative preferred and \$7,098,000 common, par \$100. The present authorized capital is one class.

* * *

The Zirconium Co. of America has been incorporated to manufacture ferro-zirconium and zirconium oxide and has acquired the property of the Baltimore Rubber Tire Manufacturing Co. at Monument and Eleventh Streets, Baltimore, Md. It is understood that the company will install electro-chemical equipment to produce one ton or more of ferro-zirconium and one-half ton of zirconium oxide daily. The officers are: George F. Dixon, president; Philip G. Spencer, vice president; Charles W. Smiley, secretary, and Morris Meyer, treasurer.

* * *

Province of Quebec, Canada, supplies 85 per cent of the asbestos requirements of the world, but only a negligible quantity is turned into manufactured products locally, this being done mainly in American plants, which are the chief consumers. The large output, amounting in the statistical year 1919-1920 to 174,251 tons, valued at \$11,758,234, has encouraged the Quebec Government to place the industry under governmental control by compelling a condition in mining leases that plants be established in the province for the manufacture or partial manufacture of the raw material. This projected Governmental action parallels the legislation enacted some years ago covering the pulp wood industry.

The Franco-American Chemical Works, Carlstadt, N. J., has increased its capital from \$100,000 to \$250,000.

* * *

Erich G. Keiner, William and Jacob Lubetkin, of Newark, N. J., have incorporated the Keiner Co., capital \$125,000, to manufacture chemicals.

* * *

Memphis Packing Corporation, Jos. Newburger, president, will enlarge its plant by the addition of a lard refinery and soap plant.

* * *

The United States Industrial Alcohol Company has awarded the contract for its new Long Island plant to the Fuller Industrial Engineering Company, 949 Broadway, New York.

* * *

Bethlehem Chemical Company, makers of explosives, has been incorporated in Philadelphia with a capital of \$3,500,000. Incorporators are Dallett H. Wilson, Howard A. Lehman and Harrington Adams of Bethlehem, Pa.

* * *

Calumet Baking Powder Co., Chicago, Ills., has acquired the plant and business of the Superior Chemical Co., Joliet, Ills., manufacturers of baking powder chemicals. Reported consideration was approximately \$1,000,000.

* * *

The Wyoming statute, which has been in force for a year, prohibiting the use of natural gas in the manufacture of carbon black, has been repealed by the State Legislature but vetoed by the Governor.

* * *

Growth of utilization of Louisiana pine for pulp manufacture is represented by the enterprise of the Bastrop (La.) Pulp & Paper Co., which will erect at that place a \$75,000 plant and later engage in paper manufacture.

* * *

The De Pont Fabrikoid Co., Inc., with plant at Newburgh, N. Y., 91.2 per cent. of whose stock is owned by E. S. du Point de Nemours & Co., Wilmington, Del., has been acquired by the latter corporation and is now operated as its fabrikoid division.

* * *

International Nickel Co., 43 Exchange Place, New York, will soon break ground for its new plant at Huntington, W. Va., for the manufacture of rolled nickel and monel metal products, estimated to cost in excess of \$1,000,000 with machinery. W. D. Witherspoon is consulting engineer.

* * *

The Darco Corporation, capital \$3,000,000, is being organized at Fairbanks, La., to manufacture decolorizing carbon from lignite for use in sugar refining. R. A. Demme, chemical engineer, has demonstrated its practicability and is backed by interests allied with the Southern Carbon Co. in the erection of a plant at Monroe, La.

WANTED

Director of Research by an Industrial Research Laboratory near New York. Require a creative chemist who is not afraid to soil his hands by working in laboratory with assistant chemists, and who can inspire enthusiasm and loyalty in the staff. Good salary and opportunity to become associated with commercial developments on excellent basis.

Address R-25, care this journal.

CHEMICAL AGE

A CONSOLIDATION of THE CHEMICAL ENGINEER and CHEMICAL AGE

LLOYD LAMBORN, *Editor*

VOLUME 29

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NUMBER 4

Dr. Ernest Fox Nichols

President, Massachusetts Institute of Technology

Appointment Effective July 1, 1921

THE selection of Dr. Ernest Fox Nichols as the successor of Dr. Richard C. Maclaurin, pending the interim incumbency of Prof. Elihu Thompson, for the presidency of the foremost scientific school in the world, is notable not only for the attainments and fitness of the man, but for the absence of the carping spirit displayed by some Yale men in the selection of Dr. James R. Angell, of the Carnegie Corporation for the presidency of that institution.

The Corporation of the Massachusetts Institute of Technology selects the best man available to personify the aims and functions of its institution, and finds its confirmation in the unqualified approval of Tech. men everywhere.

It is fortunate that the era of organized service to Industry represented by the Technology Plan, upon which the Institute of Technology entered under the auspices of Dr. Maclaurin and with the substantial aid of George Eastman, will be continued unbroken by Dr. Nichols, not alone in increased efficiency of co-ordination between a great scientific institution and industry, but as a tribute from one co-worker and friend to another.

The past president and the new president of the Institute of Technology were close personal friends. Each had a high regard for the intellectual and executive attainments of the other. But, more important still, their views on the subject of scientific education coincide. Dr. Nichols is a full believer in the theory first enunciated by Dr. Maclaurin, that an engineering school is not doing its complete duty to itself unless it establishes the closest possible



DR. ERNEST FOX NICHOLS
President
Massachusetts Institute of Technology

possible relations with the industry of the country.

Teacher, college president and investigator—all these things Dr. Nichols has been, but it is as scientist that he is best known.

Dr. Nichols was born in 1869 at Leavenworth, Kan. He received his early education in the West and was graduated at the age of nineteen from the Kansas Agricultural College with the degree of bachelor of science.

The next year he spent in teaching and the following few years as a graduate student in mathematics and physics at Cornell University, where he held the Erasmus Brooks fellowship. He received from Cornell the degree of master of science in 1893 and of doctor of science in 1897. In 1892 Dr. Nichols was appointed to the chair of physics and astronomy at Colgate University, where he remained for six years. More than two years of this time, however, was spent on leave of absence, during which he

studied under Professors Planck and Rubens, of the University of Berlin.

While a student in the Berlin laboratory he made several discoveries which were received and published by the Royal Prussian Academy of Sciences. In collaboration with Professor H. Rubens, he published a research entitled "Certain Properties of Heat Waves of Great Wave-Length." That research not only extended over knowledge of the properties of long light waves, but it also gave physicists new methods of attack. It was during the performance of this experimental work that Professor Nichols devised a new form of the radiometer, by means of which radiant energy could be measured with great precision. After his

return to America he used this instrument at the Yerkes Observatory and the Mount Wilson Observatory, California, in attempts, largely successful, to measure the heat from the stars and planets.

His Early Investigations

In 1898 Dr. Nichols was called to the professorship of physics in Dartmouth College, where he reorganized the physics department, and made it one of the strongest and most efficient departments in the college. During the first two years at Dartmouth he made the first measurements of the heat received from several of the brighter stars and planets, by using a radiometer of his own invention. In the new Wilder Laboratory of Dartmouth College, Professor Nichols, with Assistant Professor Hull, in 1901, discovered the pressure of a beam of light. This discovery, and the difficult and accurate measurements of the new force, won immediate and world-wide recognition for both men.

After five years at Dartmouth, Dr. Nichols was called to the chair of experimental physics in Columbia University; but before he assumed his new duties, Dartmouth gave him the honorary Doctorate of Science.

The year 1904-05, Dr. Nichols spent at Cambridge,

England, and lectured at the Royal Institution in London and the Cavendish Laboratory of Cambridge University. On his return from Cambridge he was made for two years in succession, Ernest Kempton Adams Research Fellow of Columbia University, in addition to the duties of his professorship. He remained at Columbia until 1909, when he was called to the presidency of Dartmouth.

Dr. Nichols was president of Dartmouth seven years, resigning in 1916 to become professor of physics at Yale. This latter position he held until 1920, but during the war he was associated with the Bureau of Ordnance of the Navy Department, for which he developed certain valuable optical devices, the exact nature of which cannot even now be disclosed.

For the last twelve months he has been director of the physical research at the Nela Park Laboratory of the National Electric Lamp Association, Cleveland, Ohio, where he is said to have gathered about him a notable staff of scientists representative of every phase of illumination investigation.

President Nichols has received honorary degrees from a number of colleges, and is the author of many articles on scientific subjects. He is married and has one daughter, recently graduated from Smith.

Salaries of Teachers in Technical Schools

Trevor Arnett has made for the General Education Board, 61 Broadway, New York, which was the fiduciary recipient in December, 1919, of \$50,000,000 in securities from John D. Rockefeller, for the corporate purposes of the Board, an investigation into the pre-war and post-war salaries of teachers in certain schools of law, medicine and engineering.

The data in the following tables were obtained by means of questionnaires directed to the several institutions.

We wish to contrast the remuneration of teachers of applied science whose service to the Nation lies at the foundation of its material greatness and their attitude toward problems of the common welfare, with

the remuneration of the unionized railroad employees and their corresponding attitude.

The maintenance of railroad properties and the provision of service at a rate that encourages growth are vital to National welfare.

We wish to emphasize the contrast between the pay and service of teachers of applied science and the pay and service of organized railroad employees who by reason of the importance of transportation and the cowardice of politicians exercise a power out of all proportion to their common rights and privileges as citizens, and who in the brazen exercise of that power would weaken and destroy, as was done in Russia, the social-serving classes in the tyranny of class government.

PROFESSIONAL SCHOOLS	NO. OF INSTITU- TIONS	PERSONS IN FACULTY REDUCED TO A FULL-TIME BASIS		TOTAL SALARIES PAID (DOLLARS)		AVERAGE SALARIES PAID (DOLLARS)		PER CENT. OF IN- CREASE
		1914-15	1919-20	1914-15	1919-20	1914-15	1919-20	
LAW								
New England States.....	1	6.0	9.5	27,000	55,350	4,500	5,826	29.4
Middle Atlantic States.....	5	33.2	41.2	98,466	130,365	2,578	3,164	22.7
Southern States.....	7	32.9	30.1	61,349	73,945	1,865	2,457	31.7
Middle Western States.....	8	44.7	49.3	123,944	160,918	2,773	3,264	17.7
Western States.....	2	8.0	9.0	27,500	40,750	3,437	4,528	31.7
Totals.....	23	129.8	139.1	338,259	461,328	2,606	3,316	27.2

MEDICINE								
New England States.....	3	29.1	45.9	68,738	142,085	2,362	3,096	31.1
Middle Atlantic States.....	4	121.1	172.0	214,520	330,315	1,771	1,920	8.4
Southern States.....	6	144.1	152.3	247,126	305,402	1,715	2,005	16.1
Middle Western States.....	4	74.5	118.3	178,435	344,586	2,395	2,912	21.5
Western States.....	2	19.5	24.5	45,775	75,880	2,347	3,097	31.9
Totals.....	19	388.3	513.0	754,594	1,198,268	1,943	2,336	20.2

ENGINEERING								
New England States.....	6	429.7	450.4	710,985	984,924	1,655	2,187	32.1
Middle Atlantic States.....	10	336.7	369.2	564,492	767,093	1,676	2,078	24.0
Southern States.....	2	14.0	21.5	33,900	59,330	2,421	2,760	14.0
Middle Western States.....	9	158.9	214.5	298,143	477,236	1,876	2,225	18.6
Western States.....	2	33.5	55.3	79,400	145,783	2,370	2,636	11.2
Totals.....	29	972.8	1,110.9	1,686,920	2,434,366	1,734	2,191	26.4

Significance of Vegetable Oils in the Economic Development of the Tropics

By V. C. Finch

Department of Geography, University of Wisconsin

CAN it be expected that the tropics will ever contribute abundantly to the food supplies of the world; that they will ever develop the well-tilled fields and plantations characteristic of higher latitudes?

The question involves many considerations, both geographic and economic.* Within recent years certain tropical products and new forms of agricultural management in the tropics have been brought to our attention. Of these none have more significance, are more closely related to the problem of the fundamental necessities of the human race than are the latest developments in the plantation cultivation of vegetable oils.

Expansion of the Vegetable Oil Industry

The production of vegetable oils and their use in foods and industrial wares is not a new thing. The olive long has supplied large domestic requirements for oil and has yielded a surplus for export. With the development of great industrial populations in Europe animal fats and domestic oils failed to suffice; as many as thirty years ago the oil dealers of Marseilles and Hamburg were endeavoring to increase their supplies by drawing upon the surplus of uncultivated oils available in the tropics. Vegetable margarines, cooking fats and soaps became abundant in Europe. They found a place even in America, where a relatively larger animal industry retarded the demand for vegetable oils. In America also there was available a great supply of cotton-seed oil, and our requirements from the tropics have been small until of very recent years.

Growth of American Imports of Tropical Oils

With the advent of the World War, it early became apparent that one of the critical links in the chain of self-sufficiency was the available supply of fats and oils. The Central Powers were isolated from a supply which for years they had been fostering within the tropics. The allied nations, beset by difficulties of shipping, turned to America for fats and oils.

So it came about that this vast unclaimed supply of oils and oil seeds poured in upon America, was manufactured and combined with domestic products and poured out again to the satisfaction of allied needs. The volume of this flood of new trade is shown by the following increases in American imports of important oil and oil seeds between the years 1911 and 1918:

	1911 Pounds	1918 Pounds
Coconut oil	48,000,000	356,000,000
Soya bean oil	11,000,000	335,000,000
Peanut oil	2,500,000	60,000,000
Peanuts (shelled)	1,000,000	68,000,000
Copra	50,000,000	430,000,000
	113,000,000	1,250,000,000

Although European buying since the close of the war has to some extent lessened the importations of the United States, the items listed above total 970 million

pounds for the fiscal year 1919-20. Obviously America is interested in the production of vegetable oils.

Future of the Industry

The prospects for the vegetable oil producers are for a future of gradual expansion. This situation is indicated by various facts.

I. Industrial chemists are reporting at frequent intervals on some new combination or process by which vegetable oils can be substituted for animal fats or by which they can be made applicable to new industrial uses. Of these discoveries the process of hydrogenation serves as a remarkable example.

II. The animal industries of the world, while capable both of intensification and a real expansion, are not able to provide for the future the abundant supplies of butter, lard and tallow to which peoples and industries have been accustomed in past decades.

III. There is prospect of further industrial expansion in Europe and America and of new industrial areas in China, Australia and perhaps elsewhere. These changes will build up populations which must depend in part upon imported foods, including fats and oils. It is not likely that the growth in the world's production in vegetable oils will be as phenomenal as has been the growth of the foreign trade of the United States in these products, but growth appears to be certain and, looking forward to a long future, it may acquire very much larger proportions than now.

Geographical Classification of Vegetable Oil Seeds

A survey of the world's trade in the principal vegetable oils and oil seeds indicates that from the standpoint of volume these products fall into two groups.

The first includes cotton seed, flax seed, the soya bean and peanuts. Each of these at present is produced entirely or in large part within the limits of the temperate zone. In these regions the oil seeds come into direct crop competition with the cereals and with other crops necessary to the support of domestic populations. It is true that cotton seed is a by-product of another essential industry. But it is equally true that the demand for soya oil has stimulated the production of this crop in China, Manchuria and Japan where the area devoted to the production of foods for local consumption is none too large.

The second group of oils and oil seeds consists principally of the products of the palms; coconut oil and copra, palm oil, palm nut oil and palm kernels. These products are obtained solely from within the limits of the tropical zone, regions for the most part not densely populated; regions in which geographical area is not a critical factor in agricultural development. The peanut may be mentioned as a tropical product also. The rapidly increasing demand for peanut oil has led to the extension of this crop not alone in the temperate zones but well within the borders of the tropics.

Geographic Specialization in Crop Production

As has been indicated, the economic pressure upon the land of the temperate zones is not yet sufficient

*Address before the Association of American Geographers, Chicago, December 31, 1920

and perhaps it never will be sufficient to drive the oil seeds out by the competition of other crops. The questions fairly may be asked, however, whether an approach to that condition of affairs is not gradually coming about and whether if it does come, the tropics will be able to supply the world's requirements in edible and industrial oils. Many things point to an affirmative answer to both of these questions.

The possibility of such changes brings up the whole question of the future of the tropics. Various geographers have expressed their opinions, some of them decidedly adverse, on the possibility of any considerable agricultural or industrial developments within the tropics, particularly the equatorial section of the tropics.

Before reviewing briefly facts which are significant of recent progress in the tropical oil industry and of its future, attention may be called to certain developments which bear upon this general problem. In spite of unfavorable reports upon the tropics current in recent years there have gone on in widely separated parts of its most difficult equatorial sections remarkable developments in scientific agriculture. Plantation rubber, principally Malaysian, in one decade (1908 to 1918) increased in percentage of the world's crop from 3 per cent. to 83 per cent. Cacao developed from a casual crop on the coast of Ecuador into a principal crop in Ecuador, the Amazon valley and the Guinea coast of Africa. The explanation of these changes is to be found in increased demand for the product in a rapidly expanding market. Conditions of climate have been met. The labor has been found. Supervision, machinery and transportation have appeared at the demand of the insistent buyer.

With regard to the production of tropical oils it may be conceded that the principal impetus for expansion will come from a demand which already has arisen and which apparently will increase in the future. With the development of a great market the principal factor of economic limitation will have been removed. In how far, then, will the production of vegetable oils in the tropics be conditioned by geographic factors?

Climatic Conditions

It is obvious that the greatest, the most far-reaching geographic influence on tropical oil production is that of climate. It expresses itself in so many ways. The variety of plants, the sites of plantations, the problem of labor, the harvesting, curing and transportation of the oil seeds, all are matters of importance in the success of the industry and are influenced by conditions of tropical climate.

Without doubt the leading and certainly the most widespread of all tropical oil-seeds is the coconut. Its climate range includes practically the entire tropics. Experience demonstrates that the industry finds ideal climatic environment in tropical regions with a minimum annual rainfall of about 60 inches. Fairly uniform distribution of precipitation throughout the year is desirable, particularly if the amount approaches the minimum. In any case, a dry season of more than three months is likely to prove detrimental.

The development of the fruit and the curing of the crop under primitive conditions are aided by the largest amount of bright weather to be obtained in conjunction with the requisite rainfall. The tropical typhoon is a constant menace but not a critical climatic factor. Until the present there lingers a supposition that the coconut palm will thrive only within the reach of a strong marine influence and salt air. Successful coconut planting in the northern interior of French Indo-

China has, however, proven this a fallacy. Although coconut collection is native to Polynesia, it has now spread to nearly every humid tropical coast in both the new world and the old.

As an agricultural industry, however, coconut planting is at its best in Malaysia, the Dutch East Indies and the Philippine Islands. The principal climatic difficulties in handling the crop in these regions are those experienced in drying the copra. The development of moulds on the drying meats rendering necessary in primitive drying processes. Smoking reduces the quality of the copra. Plantation management, skilled oversight, and machinery for rapid drying now obviate this difficulty in many regions.

Competitors of Coconut Oil

Coconut oil, while suitable for many industrial purposes, has tropical competitors. Most important among these are the fruits of various palms quite closely related to the coconut palm. Valuable species of these palms inhabit both the old world and the new, in a considerable variety of climatic regions. The Cohune and Corosso palms thrive in Central America and Colombia, the Babassu in Brazil, and the far-famed African oil palm (*Elaeis Guineensis*) on the Guinea coast of Africa.

All of these bear fruits in bunches like the date palm. The fruits consist of an outer more or less oily pericarp surrounding a nut with an oily kernel. The oil palm (*Elaeis*) of which new and better varieties constantly are being discovered, has many things to commend it for general plantation purposes. The pericarp is thick and very oily and yields the palm oil of commerce so necessary in tin-plate manufacture and also used as soap-stock. The shell of the nut is thin and easily cracked. The kernels obtained are capable of shipment over long distances and when crushed yield an edible oil almost identical with that of the coconut. This valuable palm is being extensively planted in the Straits Settlements, Java, Sumatra and Indo-China, and may eventually displace the native palms of America.

In case, however, *Elaeis* is found unadapted to certain areas there are the above mentioned American palms which yield kernels of almost identical nature though encased in a thicker shell and a less valuable pericarp. With the numerous varieties of these palms already known, it is believed to be theoretically possible to turn practically all of the humid tropics into a vast forest of palm groves so far as the relation of climate to the botanical aspect of the industry is concerned.

Production Problems Being Solved

In the relation of climate to the economic considerations of tropical oil production there is perhaps not room for so great a play of optimism. The difficulties of labor and management under tropical conditions are no small problems. The most encouraging feature of the situation is that these questions are being successfully answered in practice, whatever their theoretical difficulties.

Certain aspects of the management of these oil crops may be mentioned as contributing to the probability of their continued success. The labor requirement is not large in proportion to the value of the crop. In the clearing of new land the cutting and burning of the timber or the plowing of grass land is the only preparation required for planting. This work may be done more or less thoroughly in proportion to the

abundance of capital and labor. During the growth of the trees cover crops may be planted for weed control and then plowed in. If labor is abundant catch crops which require harvesting are sometimes used.

The harvesting of tree crops in the tropics does not require the concentration of labor characteristic of temperate zone crops. Usually there are fruits in various states of maturity at the same time. In coconut plantations the harvest is conducted at intervals of from eight to ten weeks. This type of employment is suited ideally to labor accustomed to the methods common in tropical climates. It may be said then that if any phase of agricultural industry is likely to establish itself as a widespread and general success under conditions of tropical climate it will be that phase dealing with the tree crops rather than with annuals. It also will take the form of capitalistic enterprise with efficient plantation management as opposed to individual initiative. These facts are abundantly evidenced by the conspicuous success of the tea industry in Ceylon, rubber in the Straits Settlements, and bananas in Central America.

Topographic and Soil Factors

The topographic and soil factors in the environment of the tropical oil industry influence distribution and available area in a minor way only. The principal varieties of the coconut and the varieties of *Elaeis* now under cultivation are confined for agricultural purposes to elevations of less than 1,500 to 1,600 feet. Among the other possible oil seeds, however, some are more tolerant. In any case, the areas excluded from the possible domain of the coconut and *Elaeis* by reason of topographic unsuitability are relatively small. The coconut and oil palms are very tolerant as to soil. The principal caution to planters in this regard is to avoid soils so heavy or situations so low that the ground water circulation diminishes to the point of stagnation.

If the whole of the tropics were capable of yielding rich oil seeds for human consumption it would be of little benefit to the crowded sections of the world if these seeds and their products were of such a nature as to be economically incapable of transportation. Fortunately, however, this aspect of the problem is one which finds satisfactory solution in practice. Palm

kernels and crude copra are abundantly capable of withstanding the incidents of ocean transportation. Copra, particularly the smoked product, requires only the cheapest forms of transport and may move in ancient sailing craft or in small lots as broken stowage on steamships.

Local Oil Milling

There is, however, a growing tendency toward milling these products in the regions of production. In the extraction of palm oil this always has been necessary. The oily pericarp of the palm fruit will not stand transportation. In recent years the erection of crushing plants in West Africa, the East Indies and the Philippines is providing oil in quantities requiring the services of tank ships.

As late as 1912 there were exported from the Philippines 170,000 tons of copra but no oil. In 1919 the exports of copra had declined to 15,000 tons, and the quantity of oil exported has increased to 130,000 tons. It is expected that the exports of copra may disappear entirely in favor of oil exports. This change has resulted from the erection in the Philippines of three large modern crushing plants and of a large number of smaller ones. The same condition extended to other producing areas bids fair to add to the agricultural possibilities of the tropics a considerable industrial enterprise as well.

Conclusions

From the facts available for this survey it appears (1) that the production of vegetable oils is an industry which may in the future be relegated mainly to the tropics; (2) that the industry is one admirably suited to the conditions of human life and labor within the tropics; (3) that there is no narrow geographical or economic limitation inherent in the tropics applying to the extension of the industry, or the transportation of its products to their regions of consumption.

It appears, therefore, that the principal limiting factor upon the development of this industry and through it the economic development of the tropics themselves is the single factor of the size of the market, the insistence of the demand for these products in the industrial regions of the temperate zones.

American Institute of Chemistry

Additional Observations on the Project of an Economic Organization of Chemists.

IN our January contribution to current thought on the project of an economic organization of chemists we emphasized the desirability of state sections of a national society which would exist not primarily as a band-wagon in which perfunctory pro-consuls hope sometime to ride, but as a mechanism for making national the virile usefulness to its members of the respective state sections.

The American Institute of Chemistry functions in the State of New Jersey as the New Jersey Chemical Society. The performance of its service in other states wherein the development of the chemical and allied industries connotes such segregation of chemically educated men as will permit ready intercourse, requires a projection into leadership of men touched with the instinct of service and not inspired by a desire to show how clever they are.

Already have been submitted numerous suggestions for usefulness to which men in their respective sections not only can add, but whose sense of responsibility in a scheme looking to a rational cultivation of class consciousness, should encourage them to reduce to action.

There is a man in Massachusetts known for 25 years to every graduate of the Institute of Technology and for the last 5 years known to every American chemist as the liveliest and most creative character in the Chemical Warfare Service, whose humanity, enterprise and wholesome life make him the logical leader of the American Institute of Chemistry in the State of Massachusetts.

There is a man in New York whose faculty of friendship and helpfulness makes him beloved by all his students. Academic, but of the market place as well, he

brings to his instruction the inspirational and the utilitarian and grounds the basis of success in service, and his men succeed.

There is a man in Philadelphia and one in Pittsburgh, of that practical disposition that turned them as teachers to production, and whose instinct of acquisitiveness has worked no sacrifice of the warmth of fellowship.

There is a man in Baltimore that has brought success to every thing he has touched, because he carried along ability, and is known to every chemical production manager as one of the ablest administrative chemists in the country.

There is a man in Washington, in Cleveland, Cincinnati, Chicago and St. Louis of the same practical type as those we have enumerated, who see the place in American chemical industry of an organization whose prime responsibility would be the utilization with the maximum efficiency to all concerned of the chemically trained recruits of industry.

Some of these we have enumerated, and others of similar caliber that will occur readily to men in their respective environments, may be obsessed with the fear that the development of the American Institute of Chemistry may involve duplication of effort, or detract from the prestige of the American Chemical Society, or that their open advocacy of the American Institute of Chemistry might be interpreted as disloyalty to the monopolistic principles of the coterie that dominates the older Society.

A thorough understanding of the service to be performed and of the ramifications of the responsibilities of that service, from class-room to consumer, easily should suffice not only to eliminate that obsession, but to enforce more strongly the conviction that between the American Institute of Chemistry and the American Chemical Society the line of demarcation is sharp and distinct.

Should these nominees balk at this exceptional opportunity to guide the aspirations of ambitious men of their own kind who need the advice and counsel of their superior experience, they can be characterized only as craven and niggardly of the favor they themselves have won.

We do not believe they will shirk the responsibility, for they will see the policy of not neglecting the opportunity to influence a large and growing element of American chemists dissatisfied with things as they are and determined that there shall be recognized and studied in an organized way problems affecting the progress of the industry and themselves, hitherto taboo in polite scientific society.

We already have discussed specifically and in a way to stimulate the resourcefulness of alert industrial chemists engaged in every branch of the work of production and distribution, opportunities and projects of usefulness, discussion and performance of which are demanded by the conditions of our time.

Recognized is the situation that the American Chemical Society has grown numerically to the degree that not only does its bulk constitute a hindrance to specific usefulness in fields that no longer can be neglected, but that its power in the hands of a few is a menace to initiative in directions that do not appeal to the "machine."

With a form of directive control no more democratic than that of Tammany Hall, the alert and growing body of industrial chemists demands such restriction of representations of power and influence as will be expressed in that division of responsibility to American

chemists that will permit quick and effective response to the needs of the chemical industry as are expressed in the aspirations of its educated workers.

We all know that in any organized body a handful of men do the work and that power flows to those willing to assume its responsibilities.

What we want to emphasize here is the remoteness and practical indifference of the government of a society to its members, whose size and multiplicity of assumed and reputed responsibilities actually induce reciprocal indifference on the part of its membership.

Let the American Chemical Society confine itself as heretofore to the promotion of the scientific and educational, popular and otherwise, interests of its members, and let the American Institute of Chemistry cultivate the economic interests of the industry as expressed in the activities of industrial chemists in the plant-work of production.

Let the American Chemical Society consider such projects as the perpetration of correspondence courses in chemistry, the establishment of a juvenile journal of popular chemistry for the propagation of a breed of beaker-boys and the distribution of a gratuitous press service to provide newspapers with fillers and hack-writers with jobs.

Let the American Institute of Chemistry eliminate problems of how to spend the money of its members by men who never have been headliners in capacity to make it, but to take unto themselves the consideration of eternal and ever-present problems of making a living and of making a place for chemically educated workers, and the bigger problems, in the solution of which only the former problems can be solved, of increased efficiency and greater service of the work of production in the chemical and allied industries.

Lignite Research

Dr. Erich W. Zimmerman, professor of commerce of the James Millikin University, Decatur, Ill., has been detailed by the United States Bureau of Mines to make an investigation of the fuel situation in the Dakotas, Minnesota, and nearby states, with a view to determining the extent to which carbonized lignite might find a market in that general region. Dr. Zimmerman will make a close study of the fuel supplies available in the Northwest, the characterization of these fuels, and the prices obtained therefor.

The Bureau of Mines is assured that the lignites of the Northwestern States, which are deficient in other solid fuel, can be converted into a high-grade smokeless fuel, the process yielding quantities of gas, ammonia, oils and tars as valuable by-products. With the practicability of the carbonization process assured, it remains only to consider the economic side of the situation, and to determine whether the carbonized lignite can compete with the high-grade coals of the Central Mississippi and Ohio valleys, which are now being shipped by long freight hauls into the Northwest.

Because of the large content of moisture in lignite, its tendency to disintegrate and its liability to spontaneous combustion when stored, it is not a desirable fuel as mined, and millions of tons of bituminous and anthracite coals are shipped annually into the lignite-bearing regions. The results are high prices for both industrial and domestic fuel, the imposition of a great handicap on the industrial development of these regions, the tying-up of much transportation equipment needed for other service, and other economic lost motion.

The Chemical Engineer in Biscuit Manufacture

A Survey of the Requirements, Responsibilities and Opportunities of the Chemically Trained Man in the Baking Industry

By Julius Rohn, '12, Ch.E., Columbia University

Manufacturing Superintendent (New York City), National Biscuit Company

THE importance attained by biscuit manufacture among its kindred food industries, which fall within the category of the chemically controlled industries and are essentially chemical industries, although for statistical purposes are never so considered, is indicated by an annual gross business in excess of \$350,000,000 and requiring the services of over 100,000 people.

Notwithstanding the rapid growth and increasing possibilities of this branch of food manufacture, service therein not often is thought of as a profession to be entered upon by graduates of technical schools. The purpose of this statement is to emphasize the opportunities that this industry offers to young technical professional men and to submit them to those keen to bring together the place and the man.

Mechanical Progress

The display of inventive ingenuity and its application in every department of American industry have been exemplified in the development of the mechanical equipment of the biscuit business. The growth of a business that depended upon the production of quality-goods that could be sold at a price that would encourage greater consumption, made imperative the utilization of labor-saving machinery. The wide expanse of the market for food products easily susceptible to deterioration made time of manufacture and quickness of distribution the essence of commercial success. Four machine units were necessary to transform production from direct hand labor, with much of the inefficiency incident to procedure but few removes from a household art, to mechanical manipulation in large scale production.

These devices, in sequence of their use, are: (1) the dough mixer which makes possible the mixing of dough in large batches; (2) the dough brake, which rolls the dough into sheets and repeats the familiar use of the bread board and the rolling pin; (3) the cutting machine, which performs with great rapidity and accuracy the separation of the individual biscuit; and (4) the mechanical oven, which makes possible continuous baking with elements of efficiency absent in the intermittent process of the hand oven.

These four units were all operated by hand or foot power and were in use until the middle of the 19th century. At this time the first mechanically driven dough brake and cutting machine were introduced, fol-



JULIUS ROHN, Ch. E.

Julius Rohn on graduation as chemical engineer, left the beaten path and got a job as a working student with the National Biscuit Co., in New York. As such, he remained two years, during which time he learned the trade and became a skilled hand in the various operating departments in six plants of the Company in New York. He then was given full rein as efficiency engineer to make his own position. He is now manufacturing superintendent of the seven plants of the National Biscuit Co. in New York City.

lowed shortly by a mechanically operated reel oven that developed later into the oven in use today. About 1861, the first mechanically operated dough mixer was introduced. By 1880, the basic principles of baking machinery were fully established. Since then rapid strides have been made toward perfection of these principles, resulting in greater efficiency, output, and saving of labor.

Chemical Progress

While the progress shown in the mechanical history of this industry has been rapid, the same cannot be said for the chemical side of the industry.

In the old-fashioned bakery a distinct line existed between the bake shop, which can be called the manufacturing division, and the business or executive branch. In the executive department, the head of which usually was the owner, were found the progressive business men who developed the industry. Here the financial affairs, the purchase of raw material and selling were controlled.

In the manufacturing branch an entirely different state of affairs existed. The bake shop was run by a "practical" man, a man having little education, usually starting in the baking business as a boy and learning the mysteries of dough mixing, baking, etc., step by step, from his father, and in time becoming the ruling factor of the bake shop. His formulae and methods were carefully guarded as his own personal property and any attempted innovation from without his personal sphere was looked upon as an intrusion to be resisted stubbornly. Thus the executive branch, more interested in selling and purchasing, left the important matter of efficiency of manufacturing in the hands of this more or less non-progressive element, with consequent laggard growth in efficiency.

As the biscuit business grew and the personal bakery expanded into companies and corporations and with the rapidly increasing cost of labor and raw materials, the executive department became more interested in the actual manufacture. Reduced profits and often losses, compelled the search for efficiency and economy, and so the distinct line between the executive and manufacturing branches crumbled. Other important factors in this change were the enormous quantities of raw materials now used and the introduction of substances altogether new to the biscuit manufacturer.

The producers of raw material saw this new market

opening up and started experimental and research work that later the baker continued. Also the executive heads began to realize the necessity of uniformity, quality, and the danger of adulteration in raw materials. Accordingly we find biscuit companies having outside analytical laboratories reporting on the purity of their raw materials, and so the foundations were laid for the application of chemistry in the biscuit world.

Logically enough, the next step was that of presenting small difficulties and problems to these laboratories. As the educated men in the executive branch came more and more in contact with the manufacturing end, they frequently found employed methods that were crude and wasteful, and having realized the value of the chemical laboratory for raw material, they sought to utilize this same instrumentality to modernize the bake shop. This step, however, was not very successful. The chemist knew practically nothing of the cracker industry and saw the business only through the eyes of his profession. The bake shop boss, resenting the intrusion of the technical man and seeing the business from an entirely different viewpoint, was a difficult person to combat. Thus this attempt reached an impasse.

The value of chemistry in connection with baking having now been demonstrated, small laboratories were installed in the bakeries. At the start their main object was analytical work, but in many cases the laboratory soon reached out into the bake shop and original research work started. This is how the situation stands today, the success and amount of research work depending upon the foresight of the company and the initiative and ability of the personnel of the laboratory.

Chemical Research

An enumeration of the most important raw materials used and some of the problems connected with their use, will show the extent of the field of this branch of food manufacture for industrial research. The following brief summary of some of the chemical problems to be solved in this industry is given from the non-technical viewpoint of the manufacturer.

Flour

Flour, of course, is of first importance. In sponge work, practically all the problems of the bread manufacturers are found. Here is found the question of strength of flours. A strong flour from the hard wheats of Kansas, with perhaps a blend of spring wheat to give the lightness, crispness and yields per barrel, is preferred. But the well-known difference in the strength of flours between the annual wheat crops from the same locality, due to varying climatic conditions, gives a very uncertain basis to work on. Therefore, the question of controlling this variable factor and obtaining flour of desired strength is one that well may be investigated. Partial success has been obtained by treatment of the flour with certain mineral salts, but has not been put into successful commercial operation.

In the sweet branch of the business, a softer flour is desired and an opposite problem presents itself. The annual crops of winter wheat are sometimes very strong and the necessary soft flours are then at a premium and at times even unobtainable. The proposition in this case is a method to soften the flours. This has been attempted in several ways, but with very little success.

A somewhat limited use of other cereals, such as corn flour, corn starch, rye flour, oatmeal, and barley

flours, is made, and the war has shown that they have great possibilities.

Shortening

The next important group of raw materials is shortenings. Under this head are lard, butter, cocoanut oils, cotton seed oils and compounds, peanut oil, corn oil, and hydrogenated fats. Shortening constitutes one of the most costly ingredients of the biscuit; upon it depends the tenderness, or shortness, of the finished product.

In order to study the most efficient use of shortening an exhaustive research, both chemical and microscopic, should be undertaken to determine the exact action that makes this material produce shortness in the biscuit. Is it due to the chemical action of the shortening in the dough and during the operation of baking, or to purely physical action in the baking, or a combination of the two?

Experiments have been made of the use of shortenings in the form of emulsions, impregnating flour with shortening in liquid form by means of sprays, with gelatinized starch, etc., but all in a very unscientific hit-or-miss manner.

Sugar

Sugar constitutes the third great group of raw materials. All the grades, from the dark raw sugar to the finest grade of white sugar of the refineries are used. In nearly all mixing operations the sugar is creamed with the shortening; then the liquid added, followed by the flour. This leaves a large percentage of undissolved sugar in the finished biscuit.

The question of sugar solution to obtain maximum sweetness, as a substitute for this method, is an important one. As the hardness of a biscuit increases with the increased ratio of sugar to shortening in the ordinary method of the use of sugar, an attempt to overcome this tendency might open up interesting possibilities.

Closely allied to the sugar group are the syrups of the trade, viz., molasses, sugar-house syrup, honey and glucose. Due to the greater cost of honey and the liability to impurities and adulterations, the production of synthetic honey, made by inverting sugar, is a very live problem. Few, if any, of the many invert sugar preparations on the market give the real flavor, mellowness, and soft, keeping qualities resulting from the use of genuine honey.

Leavens

The leavens, or aerating agents, used comprise substances containing carbon dioxide in a loosely combined condition, such as sodium bicarbonate and ammonium bicarbonate, and an acid or an acid salt to liberate the carbon dioxide. Tartaric acid, cream of tartar, acid calcium phosphate, and in some cases phosphoric acid, are the chemicals generally used to perform the latter function. The kinds and quantities of the chemicals used have developed simply from practical shop experience. A careful study of the best conditions for chemical reaction and the correct chemical proportions to reduce, as far as possible, the resulting by-products of the reactions, is necessary.

Eggs

Eggs, one of the highest-priced ingredients, are used to give tenderness, flavor, and color to the biscuit. Three forms of eggs are used, viz., dried, frozen and freshly broken from the shell. The important problem of the keeping quality of the biscuit would be

solved, if it could be determined whether or not the bacteria present in the raw eggs are active in the finished product.

Gelatine

Gelatine as a raw material varies greatly. To this fact, perhaps, is due the varying methods and ununiform results of making marshmallow. The marshmallow when deposited on a cake, or coating a cake, should set and dry quickly to produce maximum output. At the same time it must not become hard or gummy. As one condition works against the other, here is another complex problem awaiting solution.

Other raw materials used that would be of interest to food chemists are dried fruits, cheese, chocolate, cocoa, coconut, milk (dry and liquid), nuts, spices and flavors.

demonstrated in the manufacture of pound cake to prevent it from drying out and could probably be applied to the biscuit industry.

Doubtless many of the problems touched upon have been investigated with varying degrees of success by the numerous food research laboratories, but not in direct reference to this industry, or the biscuit manufacturer has been very slow to avail himself of and apply the scientific solutions.

Opportunities for the Young Technical Man

Thus the biscuit industry offers to the chemical graduate a virgin ground in the field of industrial biscuit chemistry. An aspirant in this sphere of work will not find well-beaten paths, but must choose his own starting point, hew his own paths and build up from the very foundation this branch of applied chem-



View in Baking Department of a Modern Biscuit Plant

The dough comes from the mixing department in large, oval tubs, from which it is transferred to the dough breakers (hooded machines in medial line of department), where it is transformed into sheets 12 feet long, one-half inch thick and of width corresponding to the feed rolls of the cutting machine. This sheet, passed through the cutter, is resolved into biscuits, which are fed automatically onto pans ready for the ovens, shown at the right. Baking is continuous; the oven in action is comparable to a ferris wheel, one revolution of which, carrying 10-12 shelves, completes the bake. The baked biscuits in pans are transferred to conveyors (shown between the ovens), which carry them below to the packing department.

Checking

The curious phenomena, the checking of biscuits, that occur mainly in the important class of biscuits known as hard sweets, have had many claimed solutions but yet never have been satisfactorily solved. The biscuits may be in perfect condition when packed, and within twenty-four hours a great percentage will have split into pieces, or cracks will have appeared, making the biscuits unfit for shipment. This strange splitting of apparently perfectly manufactured biscuits upon cooling costs biscuit manufacturers hundreds of thousands of dollars annually. Many wonderful varieties in this hard sweet class could be put on the market if it were not for this checking.

Miscellaneous

Study of the rancidity of biscuits, especially of the richer varieties, including the study of grease-proof wrapping material, the packing of export goods in tins under vacuum or under one of the inert gases (a very latest development), would be of great benefit to the packing department.

The use of hygroscopic salts has been successfully

istry. Because of the undeveloped character of this branch of applied science and the absolute lack of co-operation between the laboratory and manufacturing, several requisites for the technical man may be stated.

It is a field more for the chemical engineer than the chemist; for the man who can not only solve the problems in the laboratory, but be able to translate the laboratory procedure into a plant operation. He should not be too eager to start research work until the profession of biscuit making is fully mastered. The young graduate can very profitably spend a year or more as a student in the factory, not learning by observation, but by actual manual labor, every step in the business from the time the raw material arrives in the warehouse to the packing of the finished product. This mastered, he should try to develop along administrative lines, as far as possible, before attempting scientific research.

It is not an easy or pleasant task for a young man eager to plunge into the scientific aspects of his profession to follow patiently this path, but the fundamental knowledge thus gained will give him a unique and remunerative position in the industry.

Manufacture of Sweet Potato Flour by the "Flake" Process

A Description of Research and Results of the Procedure of White Potato Flour Manufacture Applied to the Sweet Potato

A Contribution from the Commercial Dehydration Laboratory, Bureau of Chemistry, U. S. Department of Agriculture

By C. E. Mangels

and S. C. Prescott

Chemist-in-Charge, Commercial Dehydration Laboratory

Professor of Industrial Biology, Mass. Institute of Technology

IN some sections of the United States the sweet potato is a very important crop. Until recently its commercial production was confined largely to the Middle Atlantic States—New Jersey, Delaware, Maryland, and sections of Virginia and North Carolina. The advent of the cotton-boll weevil forced the Southern planters to turn from cotton production to a more diversified form of agriculture. The sweet potato was one of the crops substituted for cotton. The production increased from 51,034,000 bushels in 1905 to 86,334,000 bushels in 1918, due largely to the increased acreage in Georgia, Alabama, Mississippi and Louisiana. A much larger crop could be produced if there were a market for it.

At least two factors have stood in the way of widening the market for the sweet potato. One is that as ordinarily handled it does not stand storage and transportation well. The other is the lack of an outlet for the surplus. The first factor is being controlled through the introduction by the Bureau of Markets of the U. S. Department of Agriculture, co-operating with the several State Departments, of improved methods of storage and transportation. To assist in eliminating the second factor by the creation of an industrial outlet in the form of sweet potato flour was the object of the investigations herein reported, and it may be said at the outset that it was not very successful.

Sweet potato flour has been produced in a small way by several processes, all dependent on drying of the sliced or cubed potatoes by the methods regularly used to dehydrate fruits and vegetables, and then grinding the dried pieces. The cost of production for such processes is comparatively high, and hence it was deemed desirable to study the preparation of sweet potato flour by the hot drum or "flake" process which is being used successfully, on a large scale, for the manufacture of flour from the white or Irish potato. The results of this study are reported in this paper.

Equipment

Arrangements for a cooperative test were made with the Williams Company at Greenville, South Carolina. This company furnished the building, power plant, a friction paring-machine and other miscellaneous equipment, and also a portion of the labor and materials. The writers desire to take this opportunity to express their appreciation of the assistance rendered in this manner by the company. The Bureau of Chemistry furnished and installed in addition to the necessary storage bins, elevators, conveying machinery and electric motors, the following main articles of commercial sized equipment: potato washer, steam pressure cooker, potato flaking machine and drug mill with receiving tanks and dust collector.

The potato washer was of the revolving paddle type made by the Potato Machinery Manufacturing Company of Minneapolis, Minn. The steam cooker was similar to the ordinary autoclave-type steam cookers except that it was provided with a false bottom and two openings, one at top for introducing potatoes and

another on the side just above the false bottom for removing the potatoes.

The potato flaking machine was the double cylinder type. The material to be flaked was introduced at the top between the cylinders or drums, and the cylinders or drums revolved in such direction as to carry the material toward the outside and down. Small rollers spread the material in a thin layer and stripper blades were provided to remove flakes. Both this machine and the cooker were of the type made by the John B. Adt Company, Baltimore, Maryland. The drug mill used was a twenty-inch Shutz O'Neil, Ltd., pulverizer and was equipped with receiving tanks and dust collectors.

Operation

The potatoes were placed in the washer, which effectually removed the dust and sand. The rotten were carefully sorted out by hand as the potatoes came from the washer. The sound potatoes were placed in the cooker and live steam passed through them for five minutes; then the valves were closed and the pressure allowed to rise to fifteen pounds at which point it was maintained for fifteen minutes. After fifteen minutes the pressure was released, the doors opened and the potatoes removed. In the process of cooking there were considerable losses of soluble material and finely divided solids, a matter which will be discussed in detail later.

From the cooker the potatoes passed to the flaking machine and were converted into flakes. The flaking machine was designed to operate with steam at 80 lbs. pressure on the drums. The large drums were designed to revolve at a rate of 8-10 R.P.M. Unfortunately, the boiler available could deliver steam at only 60 lbs. pressure. Hence, 55 lbs. was the maximum steam pressure obtainable (in the drums) without load, and when loaded with potatoes the pressure decreased to 45-50 lbs. under light load and to 35-40 lbs. under normal load. As a result of the low steam pressure it was found that the firm of sweet potatoes, even when the machine was loaded lightly, would fail to dry before it reached the stripper blades when the drums were revolved at the rate of 8-10 R.P.M. The speed of the drums, therefore, was reduced to four revolutions per minute. At this speed, with a light load of potatoes in the hopper, it was possible to dry the firm at the pressure maintained (45-50 lbs.) before it reached the stripper blades.

The lack of sufficient steam pressure greatly increased the difficulties of operation, but hardly affected the quality of the product. Cost figures of accuracy could not be obtained with this machine operating at 25 per cent. capacity.

Operated under the above conditions, the flaking machine handled the potatoes satisfactorily when allowances were made for low steam pressure. It was noted that the small spreader rollers became covered with a layer of fibrous material, which had to be scraped off occasionally. These cold spreader rolls appeared to gather up the skins (parings) of the pota-

toes. The same has been observed in the manufacture of white potato flour.

Yields

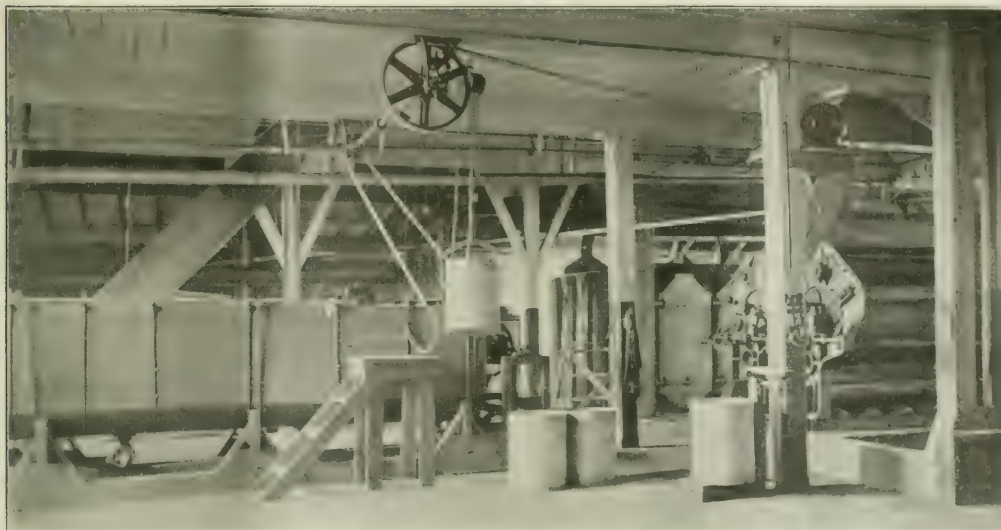
From the solid content of the sweet potatoes used one would expect a yield of over 30 per cent. of flour from sound potatoes. Table I gives the composition of the stock used. Samples were taken at different intervals.

The actual yield obtained at Greenville, figured on the basis of sound potatoes, was only 21.14 per cent. Even when generous allowance is made for all losses, such as waste on flaking machine due partially to low steam pressure, the yield is less than 25 per cent., an average of 24.74. The yield actually obtained, therefore, is in excess of 10 per cent. less than would be ex-

pected from the composition of the fresh potato. Neither of these figures takes into consideration losses due to sorting out of rottens, but are based on quantity of sound stock only.

	Wt. Liquids	% Solids	Wt. Solids
First cooking	190 lbs.	11.23	21.33 lbs.
Second cooking	195 lbs.	9.92	19.34 lbs.
Third cooking	160 lbs.	10.00	16.00 lbs.
Total solids lost—56.67 lbs.			

The weight of flour obtained from these cookings was 482 pounds, and the loss in dissolved solids (56 pounds) was equal approximately to 8 per cent. of the



View in Sweet Potato Flour Plant, Showing Potato Washer and Flaking Machine

pected from the composition of the fresh potato. Neither of these figures takes into consideration losses due to sorting out of rottens, but are based on quantity of sound stock only.

The major portion of this loss doubtless occurs in

weight of flour obtained. The low yield, therefore, is largely due to losses in cooking.

The loss in cooking, and the consequent low yield, might be prevented by modification of the method of cooking. A method of dry cooking, such as baking in an oven, might serve to prevent this loss. No facilities for trying such a modification were available at Greenville.

Influence of Quality of Raw Material on Quality of Product

Approximately 70 per cent. of the sweet potatoes used in this test were of the Porto Rican variety, and the remainder were Southern Queen and Nancy Hall. Excepting approximately 500 bushels purchased from local growers, the sweet potatoes were bought in the open market in the sweet potato growing sections of Southern Georgia in carload lots at an average price of about \$2.20 per cwt. delivered. The major portion of the potatoes were delivered after December 1 and probably suffered from chilling or frost injury.

This proved to be a serious matter, for the potatoes, though normal in appearance when received, by February 1, when large scale operations had begun, showed a large portion of shrivelled stock. To the touch these

Table I—Composition of Sweet Potatoes Used

Sample No.	Date	Variety	% Total Sugars as glucose	% Starch
20218	2/26/19	Nancy Hall	56.02	4.64
20219	2/26/19	Porto Rican	66.68	6.97
20220	2/26/19	Southern Queen	66.00	4.32
20281	3/7/19	Porto Rican	65.40	8.78
20265	3/10/19	Nancy Hall	59.90	3.94
20266	3/14/19	Porto Rican	63.80	6.32
20267	3/14/19	Southern Queen	68.60	3.95

Table II—Actual Yield of Sweet Potato Flour Obtained

Week Ending	% Rotten or discarded	% Yield on basis of potatoes used	% Yield on sound potatoes	% Yield allowing for all avoidable losses
March 22	26.90	15.32	20.00	24.78
March 29	28.57	16.36	22.50	25.78
April 5	23.16	17.48	22.00	25.71
April 12	31.48	14.37	20.97	24.58
April 19	31.40	13.67	20.00	23.71
April 26	29.84	14.27	21.32	23.87
Average			21.14	24.74

potatoes were rather flabby, and upon cutting or breaking open, the cut or broken surface, when exposed to the air, developed a green color. This condition was accompanied by a considerable development of dry rot. Even when a small percentage of such potatoes were left in the stock going to the flaking machine, the flour obtained, although of a satisfactory color when dry, would develop when mixed with water a dark, muddy green color, which was decidedly objectionable. To produce a flour which would not turn green when mixed with water, it was necessary to sort out and discard all potatoes showing even the slightest trace of injury. Even with such drastic sorting, in some lots of flour a very slight green color could be detected.

Sweet Potato Pigment

The green pigment in the unsatisfactory flours was soluble in cold water, since the cold water extract of such flours was light green in color. Acidulation with hydrochloric, acetic, tartaric or citric acids changed the color to a light yellow. If the solution was neutralized or rendered slightly alkaline with sodium bicarbonate, the green color would return upon standing 2-4 hours in the open air. Addition of an excess of ammonium hydroxide or potassium hydroxide restored the green color. Heating the original green water extract caused the green color gradually to disappear. Upon cooling and standing in an uncovered beaker for 2-4 hours the green color reappeared. When the original solution was oxidized by addition of cold nitric acid a reddish color resulted. This color was readily reduced to yellow by the addition of zinc dust. When ammonium hydroxide was added to the nitric acid solution in slight excess the green color reappeared.*

Black Rot

The Southern Queen potatoes purchased were found to be badly infected with black rot. The inclusion of a small amount of such stock imparted a very bitter flavor to the flour. Very close sorting was necessary to prevent this bitter flavor.

It is therefore evident that in the preparation of sweet potato flour the greatest care must be exercised to preserve the potatoes from injury, and to this end adequate and suitable storage, preferably in a government type of sweet potato storage house, should be available, and only sound stock should be stored for this purpose.

Modification of the Process

To determine whether the removal of the peel would improve the color, different lots were pared, some by hand, and others by the use of the friction paring machine. Removal of peels, however, either by hand or machine, did not improve the color of flour, which turned green.

It was determined that contact with iron of the machinery did not injuriously affect the color. In this connection, the acidity of sound and injured potatoes was determined, since stock of high acidity might tend to dissolve iron from the machinery. It was found that the injured potatoes were more acid. The analyses are given in Table III.

Table III—Relative Acidity of Sound and Frost Injured Stock

Sample No.	Variety	Condition	Moisture	Acidity*	
				H ₂ O Extract	Alcohol Extract
20251	Porto Rican	Normal	65.40	14.9	
20252	" "	Injured	63.98	32.0	
20266	" "	Normal	63.8	20.6	13.2
20268	" "	Injured	57.4	54.8	53.0

*C.C. normal alkali required to neutralize acid in 1-kg. fresh potatoes.

Accordingly different quantities of solid commercial grade sodium bicarbonate were added to the potatoes just before cooking. This was accomplished as follows:

After the cooker was filled with sweet potatoes the sodium bicarbonate was sprinkled on the potatoes, and especially near the sides. The action of steam would tend to carry it downward and mix it thoroughly with the potatoes. Later, to insure better mixture, the sodium bicarbonate was added in layers.

The addition of sodium bicarbonate (one pound to a charge) did not perceptibly improve the color, and doubling the quantity added had no effect. From the tests made it was concluded that the addition of sodium bicarbonate had very little effect so far as preventing the green color was concerned, and it was concluded that the green color was due to the condition of the raw material rather than inclusion of iron (see previous condition).

Properties of the Sweet Potato Flour Obtained

The flakes were golden yellow when the Porto Rican variety was used and canary yellow when the Southern Queen variety was used. The color was similar after the flakes were ground to flour. As stated above, when poor or injured stock was used, a green mixture resulted upon the addition of water.

The product was very hygroscopic and tended to harden and cake when stored in ordinary paper-lined flour sacks. This hardening took place even when the storage room was very dry, and was not entirely prevented by the use of so-called moisture-proof bags.

It is known that flour prepared from dried raw sweet potatoes does not have this hygroscopic property. It appears possible, therefore, that changes occur due to cooking, which render the product more hygroscopic. Chemical analyses of the raw potatoes used and the finished flour indicate that some starch is converted into sugar, as evidenced by larger per cent. total sugar and smaller per cent. starch in the flour.

Table IV—Starch and Sugar Content of Potatoes and Finished Flour

	Variety	Per Cent. Total Sugar as glucose	Per Cent. Starch, Moisture-free basis
	Porto Rican		
Flour	"	31.91	45.06
Fresh (a)	"	18.23	62.04
Fresh (b)	"	20.92	51.02
Fresh (c)	"	25.00	45.98
Fresh, average	"	21.38	53.01

The increase in sugar content might render the product more hygroscopic, but it is improbable that this is the sole reason for the hygroscopic nature of the flour. The hardened flour is not brittle, but is gummy and rubbery.

The per cent. of "Nitrogen Free Extract" in sweet potatoes as ordinarily determined by difference is not accounted for entirely by the per cent. of sugars and starch present, and this indicates the presence of gums and pentosans. It is probable that the cooking at 15

*Bartlett notes an ammonia green pigment in *dioscorea*, U. S. Dept. Agr., Bureau Plant Industry Bulletin 264 (1913). The pigment noted by Bartlett is ether-alcohol soluble, but gives similar color reactions with reagents. This suggests the possibility that this sweet potato pigment is of similar constitution.

Zerban indicates the relation of iron to a green, water-soluble pigment occurring in sugar cane. *Journal of Industrial and Engineering Chemistry* (1) Vol. 10, No. 10, p. 814, and (2) Vol. 11, No. 11, p. 1034. The reactions of this pigment to reagents are different than those of the sweet potato pigment.

pounds pressure gelatinizes these compounds and the starch in such a manner as to render the product hygroscopic and gummy.

Uses of Flour

The flour after hardening was not suitable for any use as food, since a strong flavor developed with the hardening.

The fresh flour, however, was suitable for the baking of cookies and bread. Bread made from 25 per cent. sweet potato and 75 per cent. wheat flour had a very acceptable nutty flavor and good texture.

For use as sweet potato-pie filler only the freshly prepared flour could be used, but the texture was rather too soggy to be desirable. The texture was improved by adding lemon juice, but this affected the flavor.

Modifications of Process

The experiments conducted indicate that this method of preparing sweet potato flour is unsuccessful, and in order to make same successful considerable modification would be necessary.

It is suggested that another method of cooking be used in which the loss of material will be less, and in which changes in composition which would render the product hygroscopic would be avoided. Baking would

accomplish the first, and probably avoid the second. Cooking with live steam instead of steam under pressure might prevent formation of the hygroscopic compound. Further, it might be possible to pulp potatoes raw, and dry, but a different type of flaking machine would probably be necessary to handle such pulp.

Summary

I. The "Flake Process," successfully used for the preparation of flour from white or Irish potatoes, is not applicable to the sweet potato.

(1) It is very difficult to secure a product with desirable natural color. Condition of the raw material is the principal factor affecting color.

(2) Even after a product of desirable color is obtained other qualities are unsatisfactory. The flour is hygroscopic and hardens upon storage to a cake of gummy consistency.

(3) The yield is much less than should be secured theoretically, due to loss occurring during cooking.

II. Sweet potato flour produced by this method does not appear to have much possibility as a food for human consumption and it is doubtful if it would be suitable for stock feed.

III. Extensive changes and modifications of process might render same acceptable.

Institute of Chemistry of Great Britain

Abstract of Address of Sir Herbert Jackson, Retiring President, on Occasion of the Forty-third Annual General Meeting.

THE discussion of the proposed economic organization of American chemists under the suggested name of "American Institute of Chemistry," which organization, as relates to the state of New Jersey, already has been affected by the assumption by the New Jersey Chemical Society of its functions, adds interest to the following abstract (*Chemical News*) of the address of Sir Herbert Jackson, the retiring president, on the occasion of the 43d annual general meeting of the Institute of Chemistry of Great Britain:

"Sir Herbert in the course of his address remarked that government departments and official authorities generally had shown more inclination in recent times than in the past to accord higher recognition to the services of men of science.

"The conditions of appointment of chemists, both in the government service and in industry, had been improved, and until the close of 1920 the profession had been in almost a unique position in that very few indeed of its members were disengaged. The prevailing depression in industry had had some effect on the employment of chemists, but even now less than 50 were disengaged out of nearly 3,300 on the roll.

"The by-laws of the Institute had undergone revision to provide for the representation of chemists from various parts of the country and practicing in different departments of work, and alterations had been made to define more specifically certain points relating to the ethics of the profession and further to restrict the membership of the Institute to British subjects.

"The Institute was taking part in many matters affecting the public life of the country where chemistry was concerned, and the annual report showed that chartered professional bodies of this character were able to render the State valuable service. The greater consideration given to science by the government was an encouragement to the coming generation of chem-

ists to follow a career of essential and vital importance to the needs of the country.

"It would probably be regarded as desirable at the present moment for the Council of the Institute, without taking part in politics, to give expression to their views on the grave importance of maintaining in this country industries on which not only the future development of our chemical industry and many allied industries depends, but the future of a very large number of students of chemistry who are now in the course of training. The Institute was entrusted by its Charter with securing the supply of well-trained chemists, but unless a great chemical industry was maintained there would be a very poor prospect for them.

"The President maintained that the Institute had throughout its existence fulfilled the purposes for which it was incorporated. It had kept alive the corporate spirit of the profession, the means whereby the opinions and views of its members found expression in matters of public concern. It was the officially-recognized public body to whom the country could turn for advice and guidance on matters relating to the profession.

"It rendered every possible assistance to those who intended to follow the profession of chemistry, and promoted and maintained the highest standard of training and competence for that profession. It registered the trained and competent and thereby supplied competent professional service for the country.

"Moreover, it promoted the strictest integrity on the part of its members in their dealings with one another and with the public, and fostered by every means in its power the status of the profession. He was confident that it would continue to gain strength and prestige."

In the light of our experience with chemical societies in the United States, the eminently practical character of this English organization is notable.

The Economic Waste of Preventable Rust and Rot

By William H. Walker, Ph.D.

Consulting Chemical Engineer

THE corrosion of iron and the rotting of wood are two sources of great economic loss which have many factors in parallel. The latter has been shown to be due to micro-organic growth, and upon this knowledge has been predicated methods for arresting or entirely preventing this loss. But notwithstanding this knowledge many structures of wood are allowed to decay with little or no attempt towards their preservation. The fact that more wood can be had to replace that destroyed is obviously considered a justification for allowing this wastage to continue. The same is true of iron.*

The fact that iron suffers from what is known as "rust" has been common knowledge for centuries; the cause of this action, and many of the factors which control its rate have been understood for some twenty years; and yet we daily see railroad bridges eaten with rust, freight cars covered with great red barnacles, hot water pipe systems breaking down, and wire fencing in tatters—all because more iron and steel can be obtained to replace that so destroyed. The fact that the cost of replacement is frequently far in excess of the cost of the material itself greatly multiplies this economic loss and makes the situation less excusable.

The mechanism of corrosion is now fairly well understood. Whitney, in 1900, showed it to be an electrochemical phenomenon, obeying the laws of electrochemistry. It was the privilege of the writer to demonstrate in 1907 the function of oxygen in corrosion, and to apply the experimental facts to the preservation of many engineering structures.

The engineering public, however, has been slow in availing itself of the published work on corrosion, probably for a number of reasons. First, the entire literature of corrosion is full of apparent contradictions and obvious misstatements. This is occasioned by the fact that corrosion is a most complex phenomenon and that factors which may be controlling in the results are frequently entirely overlooked.

No two men have the same sample of iron and steel; the heat treatment is generally different, the analysis imperfectly known; the state of the surface and the finish are neglected; and a host of other important conditions completely ignored. No wonder the results present discrepancies, and the public fails to show an interest in them.

Second, certain conclusions which in the early days seemed to logically follow from the electrochemical theory of corrosion have been shown to be erroneous, and have led to disappointing results. Possibly, as has been pointed out, the logic was false; but at any rate we cannot crown the theory with any far-reaching beneficial results. If I may paraphrase, "the evil that a theory does lives after it; the good is oft interred with its bones."

Fruitless Zeal of False Theories

The theory that the earth was flat delayed the discovery of America by a number of centuries; the phlogiston theory guided experimenters to fruitless fields of investigation and wasted time and energy. So with the doctrine that homogeneity of structure in iron and steel insures an absence of corrosion.

The public is still told through advertising propaganda that the old Newburyport bridge withstood Atlantic Ocean storms for over one hundred years because the iron with which it was built was pure and homogeneous, when, as a matter of fact, the majority of the links of the great chains were very impure and extremely heterogeneous. The further fact that when these very pure links were rolled down to sheet form and exposed to the weather, they rusted like modern iron and disappeared in a few years, is conveniently ignored. The old blacksmith's forge apparently introduced an element of protection which has not yet been predicted by the electrochemical theory nor realized by laboratory experimentation.

Classes of Corrosion

Corrosion may be divided into two classes—that taking place in the atmosphere with free access of the oxygen of the air, and that in positions from which the air is or can be excluded.

In the first field, the work of D. M. Buck stands pre-eminently the greatest contribution made in the art of preventing corrosion since the introduction of hot galvanizing. Impartial evidence is now legion that no commercial iron or steel so well withstands atmospheric corrosion as does steel containing approximately 0.2 per cent. copper. When thus alloyed even the much maligned Bessemer steel excels in resistance to corrosion the widely heralded pure open-hearth iron.

Unfortunately, copper-bearing steel is not a child of the electrolytic theory, although we have no doubt that when adequate explanation of the wonderful effect of this small amount of copper is finally suggested, it will be found to be essentially electrochemical. With the unbroken record of successful achievement now possessed by copper-bearing steel, and the low cost of metallic copper, there seems to be no excuse for the fabrication of those structures which must withstand exposure to the weather, from any other material.

But a copper-bearing steel produces its own protective covering only when the oxygen concentration is high. When the amount of oxygen is limited, as when the structure is immersed in water, other protective means must be found. If all of the oxygen in a system could be removed, corrosion would cease. This fact was early recognized by F. N. Speller, and the careful experimentation carried on by him during the last twelve years in the application of this principle to the preservation of engineering structures, is now, being crowned with success. Enough operating data from large installations are now available to demonstrate the effectiveness of this method of conserving iron and steel.

The work of Henry A. Gardner, and others, has done much to improve the protective quality of paint, while protective coatings of zinc, aluminum and tin have each received much attention. It is interesting to note also that the protection of iron structures such as a steam boiler or a condenser, by making the structure cathodic by continually passing through it a small direct current, has taken commercial form in what is called the Cumberland process, and has apparently found a place in marine engineering. While rusting iron is still an all too common sight, yet real progress is being made, and the future for anti-corrosion is bright.

* Introduction to symposium on corrosion of iron and steel at the Thirty-ninth General Meeting of the American Electro-chemical Society, Atlantic City, N. J., April 21-23, 1921.

Observations of a Packing House Executive on Technical Men as Salesmen

By George H. Rasch

President, Morris Fertilizer Company, General Manager, By-Products Departments, Morris & Co.

WHEN asked, as I often have been, whether I favor a technical education for young men who contemplate engaging in the selling end of the packing industry, and, more particularly, the by-product end, I always have been at a loss for an intelligent reply. Speaking generally, but emphatically, I favor the broadest possible education for any person contemplating any kind of a career at all. Nevertheless, my experience with technical men in sales positions has not always been satisfactory, because of the peculiar characteristics, many of them intangible and hard to analyze, that are needed to qualify a man for success in the broad art of salesmanship. After years of experience with salesmen of all types, grades, and classes, one is disposed to believe that the world is full of "order takers" or those who merely "dispose" of goods instead of selling them, and comes to believe that the real salesman is decidedly in the minority. In short, in selecting a salesman, a certain something is needed as an element of the man's success; and that differs according to the requirements of the environment.

A man may be a remarkably successful salesman in one line and fall flat in other lines, where the conditions and the character of the trade are entirely different. Consequently, in selecting a salesman, the particular disposition of the man and his adaptability for the particular work in hand are the important consideration. And that factor is ever present, without respect to the man's fundamental education.

Education in the broad sense of the word does not necessarily have to be obtained in a school or college. In fact, I know of no line of endeavor that provides greater opportunity for obtaining an efficient education than that of salesmanship, where the man constantly is brought face to face with different people in different environments under different conditions, which in itself has a very broadening influence.

We know that in this country, where the opportunities for everybody are unlimited and have never been restricted by class lines, many of our most respected men have sprung from humble surroundings, from which, in youth, they were obliged to face the world on their own account, backed up by little or no school education, but who, at the pinnacle of their success, were justly regarded as well-educated men, even to the extent that many of our colleges have conferred degrees upon them. What they had was the rough but nevertheless valuable type of education born of hard knocks and trying experiences.

My supposition is that their progress in gaining education in the early days of their career probably was slow, due in part to their struggles for an existence, but principally no doubt, to a lack of systematic training in how to "think right," which art had to be acquired slowly before their period of constructive and expansive education commenced; but having reached that point, they had learned the knack of eliminating that which was bad and of broadening out on that which was good, consequently education came faster, and they developed a great power of concentration and broad vision, so that, in the later years of their life

their natural, self-acquired education made it possible for them to impress the greatness of their personality upon the world.

Drawing from this knowledge, we must consider that in those days the man with a college education in business was the exception. The majority of college men took up a profession, either the Law, Medicine, or Theology, while the business man of that period as a rule started his career with the rudimentary instruction of the common schools.

His real education was gained slowly but surely during his contact with his more experienced associates in the business world. By this process, when he was old and gray-haired, if he combined the ability readily to absorb knowledge and build upon it, with a knack of developing a vision in business affairs, he had perhaps reached the point of perfection in his education in his chosen line, where he became a sales manager, a superintendent, or an office manager.

Right here, we get a clear view of the great evolution that has occurred because of the superior methods of education available to the young man today in colleges where specialized training is provided. This condition has brought about great changes, so that now most of the fundamental education essential to the efficient development of brain power is, on the whole, very well accomplished in our higher institutions. So the young man starts his business career with advantages denied his predecessor and reaches the point where he can assume and master responsibility at a much earlier age, when his physique and energy are at their best; and perhaps he is ready to retire at about the same age at which his predecessor had acquired executive responsibilities.

To realize this condition, it is necessary only to enter the offices of any of our big corporations and observe the almost entire absence of the white-haired executive that was such a familiar sight in the business world but a few years since. In his place, note the young, energetic, but nevertheless shrewd, keen, competent man who is filling his place; perhaps a little cruder in some respects, but better in others, because business today must be broad in order to be successful; therefore, it must reach far away from home. In days gone by, the older executives in their declining years were very apt to be conservative and were glad to let well enough alone, while the younger type of executive that holds the reins in business today is accomplishing more in the way of business expansion, because he has a long life before him and wants to broaden out, with the optimism characteristic of youth.

I urge a technical education, or any other kind of an education for a young man contemplating a career in the sales or executive end of the packing business. It sometimes has seemed to me that many of the young technical men I have come in contact with have tended toward a narrow viewpoint and lacked personal initiative when they tried to go outside of the technical branches of the business. This has caused me to wonder whether that might indicate that our modern courses in, *e. g.*, Chemistry, while a big improvement upon the courses of the past generation, are still laid out along

lines that do not combine enough constructive work with the mere study of technique.

But I know of no reason why a technical education should destroy a man's disposition to engage or ability to make a name for himself in the field of salesmanship. Technical education should be a big advantage to him, provided he will regard what he carried out of college simply as a foundation on which he has to build. Such a man so equipped should have a head start in the sales field over those of similar disposition who lack that education. Consequently the man who builds a sales career on a technical education ought to be at the pinnacle of his success by the time his less well-educated rival is just getting under way along the course.

I believe if the man has the disposition and the invis-

ible something that develops into exceptional sales ability, a technical education will be a great help, and will be of enormous value to him in the sale of packing house by-products; or, for that matter, in the sale of hams, real estate, or his own services, but he must not, as in the study of Chemistry, narrow down to the point where he declines to see either to the right or left of the rules and technique set down in his book education. He must regard that education simply as a foundation on which he is going to build the structure of his career.

If that structure prove to be commonplace or ordinary, he must not expect that it will arouse any special attention. In this world of commonplace things it is the exceptional structure that attracts attention, and demands recognition.

The British Gas Mantle Industry

ENGLAND'S desire to conserve those industries that the embargo of war compelled her to create and which are of a type denominated "Key" industries, and heretofore controlled chiefly by Germany, seeks expression in projected legislation which, as regards the dyestuffs industry already has been enacted.

American enterprise of the same character and created by the same cause will see in the statement of the Incandescent Mantle Manufacturers' Association to the British Board of Trade, a replica of its own concern as regards its own future. The gas mantle industry bases its claim to be regarded as a "key" industry upon the following considerations:

I.—Both in time of peace and in time of war incandescent gas lighting is necessary for the adequate illumination of docks, railways, factories, etc.

II.—It is estimated that 32 million tons more coal would be required yearly to produce the same illumination if flat-flame burners were used instead of gas mantles.

III.—The "stripping" of coal gas has been found necessary to ensure adequate supplies of benzol, toluol, and other hydrocarbons for the manufacture of dyes, drugs and explosives; such "stripped" gas can only be used as an illuminant in conjunction with the gas mantle.

The value of the industry from the standpoints of efficient illumination and coal conservation was recognized by Lord Balfour's Committee on Commercial and Industrial Policy, and recent legislation authorizing the sale of gas on a calorific, instead of an illuminating basis has further emphasized the importance of the gas mantle. In Germany the essential nature of this industry, including the raw materials therefor, has been recognized by granting special allocations of coal at the lowest price and supplies of gas which are otherwise restricted.

Before the war, the rare-earth chemicals and the gas-mantle industry were mainly under foreign domination. The total output of Indian monazite sand went to Germany, and British mantle-makers had to purchase thorium nitrate abroad at a price fixed by the Thorium Convention, a combine of German and Austrian manufacturers which was itself controlled by the chief German maker of gas mantles.

Further, foreign mantles were sold in England at prices 2—35 per cent. below English factory costs, and 23—70 per cent. below the selling prices in the countries of origin. In 1913 foreign importations amounted to between 45 and 50 million finished mantles

and over 11 million partly finished (about 70 per cent. of our entire consumption), and the latter were marketed in such a way as to evade the payment of British income tax by the English branch of the German combine, the Auer Gesellschaft. In the same year the English production was 22 million mantles, of which 10 million was made by a company associated with the German combine.

In consequence of this foreign domination the home industry became very precarious; nearly all the factories were running at a loss, wages were low, and employment uncertain and unsatisfactory. Hence, at the outbreak of war, there was insufficient plant to meet the country's requirements, supplies of thorium nitrate were cut off, and there was a shortage of clay rings and other materials required by the industry.

To overcome these difficulties the Indian monazite deposits were placed under British control, and five home manufacturers took up the preparation of thorium nitrate, although until the factories were ready the nitrate had to be purchased abroad at arbitrary prices which showed large profits to foreign suppliers. These factories can now produce all the gas mantles the country requires; and during the war they supplied the cerium fluoride and cerium oxalate needed for searchlights and tracer bullets.

Prior to the war all the mantle rings required by the home industry were either imported from Germany or supplied by a German-owned company with branch works in this country. These works were purchased by a group of the chief British mantle-makers and so extended that they are now able to meet the country's requirements, although not yet in a position to produce the full range of designs which were offered by the Germans. Ramie yarn, which was also derived from Germany before the war, can now be supplied by British spinning plants in sufficient quantity.

Owing to the extensions made to buildings and plant (at war prices) and to the establishment of three of four new factories, the output capacity of the home industry is now over 130 million mantles per annum, which is sufficient to leave a considerable surplus for exportation. The following data show the position of the British industry in 1913 and on October 30, 1920:

	1913.	1919-20.
Output of mantles	32,000,000	82,322,000
Capital employed	£440,670	*£1,525,710
Workers employed	1,843	3,783

*Exclusive of £350,000 invested in the thorium nitrate and other subsidiary industries.

The present annual consumption of gas mantles is valued at £1,750,000; £400,000 is paid in direct wages, and at least an equal sum as indirect wages to convert the imported raw materials into the products used by the industry, labor, and wages entering into the cost of the finished article to a degree unusual in other industries.

The raw materials used by the gas-mantle manufacturer include thorium nitrate and other chemicals, cotton, ramie, artificial silk, asbestos yarns, clay rings, and cardboard boxes. At the present time there is grave stagnation in the above trades, which is mainly due to the increasing importation of foreign mantles (over 10 million in 1920), and the prospect of further competition at prices below British manufacturing costs. The low prices of foreign mantles are the result of:—(a) Attempts by foreign makers to recapture their former markets at any cost; (b) the low rate of foreign exchanges; (c) longer working hours in foreign factories (60 hours or more per week compared with 48 in England) and the lower standard of living of the workers; (d) large pre-war stocks of certain raw materials held by German manufacturers.

The British consumer is not obtaining the full bene-

fit of the lower prices, as the intermediate profit is mainly retained by the importers and dealers. The Labor representatives on the Joint Industrial Council for the industry proposed a resolution, which was passed unanimously, deploring the increasing importation of foreign mantles, and urging the Government to take steps to counteract the effects due to foreign rates of exchange. At the present time some of the British factories are closed down, and the rest are working short time; manufacturers are carrying large stocks at a season when demand normally exceeds the rate of production; employment in the industry is declining, and generally the situation is so serious that immediate action is imperative.

In conclusion, it is submitted that the manufacture of thorium and rare-earth salts, incandescent mantles, and clay rings, be recognized and assisted as "key" industries; that legislation be introduced forthwith to protect the British worker against unemployment resulting from foreign competition; and that the British manufacturers who have responded to appeals to lay the foundations of a self-supporting industry be assured a market free from unfair competition.

Methods of Preparing Vegetables for Dehydration

A Study of Effects of Different Methods of Treatment on the Quality of Potatoes, Carrots and Cabbage

By P. F. Nichols and C. R. Gross

Commercial Dehydration Laboratory, Bureau of Chemistry, U. S. Department of Agriculture

THE development of the vegetable drying industry in the United States has resulted in new problems for scientific investigation. During the war, at the time of greatest development, the discussions centered on the type of dryer used, and little attention was paid to other important factors which influence the quality. The investigations of the Bureau of Chemistry, however, indicate a number of factors influencing quality, in addition to the type of dryer used. The method by which vegetables are prepared for drying certainly affects the quality of the finished product.

The method of preparing vegetables for drying originally used in the industry was very simple, and consisted in washing, peeling when necessary, slicing, and spreading on trays, after which products were introduced into the dryer without further treatment. This process was soon found to be unsuitable for potatoes, since the potatoes turned dark in the course of drying. The potatoes were, therefore blanched or processed with steam or hot water which prevented the darkening. Carrots and cabbage dried raw made a very presentable product when freshly dried, but these products tended to deteriorate rapidly after drying, especially if the moisture content was high. This deterioration was found to be largely due to the activity of enzymes, and the destruction of enzymes by heat treatment resulted in products of superior keeping quality. Two general methods of blanching or processing are in use—steam and hot water.

Blanching

The term "blanching" is somewhat of a misnomer. It implies a bleaching or whitening effect, but as the term is used in the canning and drying industry it may describe a deepening of color. The term "blanching" comes to the dehydration industry from the canning industry and implies that the products have been

treated with boiling water or salt solution, or steam. The term "processing" is often used in dehydration plants to describe this step in the operation of drying.

The "blanching" or "processing" given vegetables before drying virtually amounts to pre-cooking. The period of processing should be of such length and intensity that the materials are tender and heated through, but not so softened as to collapse and lose their shape when spread on trays.

Blanching by immersion in hot water as practiced in the canning industry is not now commonly employed in the dehydration industry. The dehydration plants usually have preferred steam blanching, owing perhaps to the simplicity of the apparatus required and the greater convenience of handling. The blanching by steam is referred to generally as "processing," as stated before. In this article pre-treatment by either method (steam or immersion) will be called "blanching," the treated products will be called "blanched," and the two general methods will be referred to as "blanching by immersion" or "blanching by steam." "Blanching by steam" also will be referred to as "steam processing" or "processing."

Object

The object of the investigation was to secure some information as to the relative advantages of different methods of blanching.

Procedure

Experiments were made with the following products: potatoes, carrots and cabbage. The vegetables were prepared for dehydration in the ordinary commercial manner except for blanching. In the case of potatoes and carrots, this preparation consisted in thorough washing, removing skin or peel by the use of abrasive-type paring machines, and then cutting into

slices as desired. In case of cabbage, the discolored or diseased outer leaves are removed by hand, the hearts removed by a boring machine or by quartering, and the leaves sliced or shredded to convenient size.

Portions of the freshly prepared vegetables were steamed and other portions were placed in wire baskets and immersed for different periods of time in different hot blanching solutions.

The following treatments were given each vegetable:

<i>Carrots</i>	<i>Potatoes</i>	<i>Cabbage</i>
1. Steam	1. Steam	1. Steam
2. Hot water	2. Hot water	2. Hot water
3. Hot 2% salt solution	3. Hot 2% salt solution	3. Hot 2% salt solution
4. Hot 1% baking soda solution.	4. Hot 1/10 of 1% sod. bisulphite	4. Hot 1% baking soda
5. Hot 3% baking soda solution.	5. Hot 1/10 of 1% sod. sulphite	

Immediately after blanching, the products were spread on trays and were dried in a commercial dryer of the tunnel type. The only variable, therefore, was the method of blanching used.

Results

The description of the appearance of the dried vegetables blanching in the different ways is recorded in Tables I, II and III. In these tables are also noted any cases in which a particular period of immersion resulted in either under blanching or over blanching. Each set of dried vegetable samples was arbitrarily

graded on the basis of attractiveness of appearance and grades were assigned in which A = Excellent, B = Good, C = Fair; superior or inferior degrees of attractiveness in any grade were indicated as (+) or (—) respectively. It is realized that individual tastes may differ widely in selecting attractively-colored dehydrated vegetables. The standard used in comparing these dried vegetables was to take into consideration the fact that the colors of the dried products would be more concentrated and hence deeper than those of the fresh products because of the shrinkage in bulk in drying. Those products in which the original colors were preserved and were somewhat deepened in shade, were consequently graded as the best.

Discussion of Results

Blanching of Carrots

It is possible to produce more attractive dehydrated carrots by blanching by immersion, in the order named, in hot 2 per cent. salt solution, hot 1 per cent. baking soda solution, or in hot water, than by processing by steam. A distinct gradation of color was observed, the palest color being the steam blanched products, becoming progressively darker in the products blanched by 2 per cent. salt solution, 1 per cent. baking soda solution, and darkest red in the case of products blanched by 3 per cent. baking soda solution. Especially did the use of baking soda solution intensify the color of the product. The medium-colored products were con-

Table I—*Experimental Blanching of Carrots*

Appearance and Relative Grade of Dried Products Blanched for Intervals as Follows:						
Blanching Agent	2 Minutes Appearance	Grade	3 Minutes Appearance	Grade	4 Minutes Appearance	Grade
Steam	Not tried	—	Not tried	—	Very pale red	C
Hot water	Pale yellowish red	C	Pale yellowish red	B	Rather pale red	B
Hot 2% salt solution	Medium orange red	A	Medium orange red	A+	Medium orange red	A+
Hot 1% baking soda solution	Rather deep orange red	B+	Deep orange red	A	Very deep orange red	D
Hot 3% baking soda solution	Very deep orange red	D	Very deep orange red	D	Very deep orange red	D

Table II—*Experimental Blanching of Potatoes*

Appearance and Relative Grade of Dried Products Blanched for Intervals as Follows:								
Blanching Agent	2 Minutes Appearance	Grade	4 Minutes Appearance	Grade	5 Minutes Appearance	Grade	6 Minutes Appearance	Grade
Steam	Well blanch'd	A	Not tried	—	Over blanch'd Mealy	C+	Over blanch'd, Unsalable	D
Hot water	Centers darkened, under blanch'd	C+	Well blanch'd	A—	Well blanch'd	A—	Fairly well blanch'd	B+
Hot 2% salt solution	Ditto	C+	Ditto	A—	Ditto	A—	Ditto	B+
Hot 1/10 of 1% sodium bisulphite	Slightly dark, under blanch'd	C	Well blanch'd	A	Well blanch'd	A	Not tried	—
Hot 1/10 of 1% sod. sulphite	Ditto	C	Ditto	A	Ditto	A	Not tried	—

Table III—*Experimental Blanching of Cabbage*

Appearance and Relative Grade of Dried Products Blanched for Periods as Follows:						
Blanching Agent	1 Minute Appearance	Grade	2 Minutes Appearance	Grade	5 Minutes Appearance	Grade
Steam	Green and yellow	C+	Green and dingy yellow	C	Yellow and light green, over-processed	D
Hot water	Yellow and slightly green	B—	Yellow and slightly green	A+	Green and yellow, over blanch'd	B
Hot 2% salt solution	Green and white	A	Yellow and slightly green	B+	Green and yellow	A—
Hot 1% baking soda solution	Green and yellow	C—	Green and yellow, over blanch'd	D+	Green and yellow, over blanch'd	D—

NOTE—Under "Appearance," the predominating color is placed first.

sidered the most attractive, and the two extremes, especially the dark reds, were judged least attractive. The dehydrated and cooked samples of the carrots blanched with 3 per cent. baking soda solution retained some of the taste of the soda and were off flavor. In all other cases, there was little difference in the taste of any of the samples.

Blanching of Potatoes

No method of blanching by immersion among those tried produced a better product than that obtained by steam processing, but blanching by immersion in hot solutions of 1/10 of 1 per cent. of sodium bisulphite and of 1/10 of 1 per cent. of sodium sulphite, produced equally as attractive white products, while blanching in hot water and hot 2 per cent. salt solution, resulted in almost as attractive appearing products.

Under the conditions of this experiment, the best period of immersion of potatoes lies, for all blanching agents except steam, between four and five minutes.



Fig. 1. Steam Blancher—Chamber Type

perature in the chamber depends upon the condition and temperature of the steam and upon the rapidity and completeness with which it fills the chamber.

The rapidity with which any product will assume this temperature will depend upon the nature of the product, its state of sub-division, and the depth to which it is spread on the trays and the arrangement of the trays. It is, therefore, often impossible to judge the proper time of blanching. When we consider that the blanching is accomplished in a very few minutes, usually much less than ten minutes, it will be obvious that the deviation of a single minute from the proper time may produce an improperly blanched product. For these reasons, steam blanching is not as dependable as desired.

Equipment

Two types of commercial equipment are now used for steam blanching, i. e., (1) the steam chamber, and (2) the conveyor type.

The steam chamber is most generally used, and in



Fig. 2. Steam Blancher—Conveyor Type

Two minutes is too short to allow sufficient heat to penetrate to the centers of the cubes which become darkened. Six minutes is too long, and while the products are sufficiently white, their appearance suffers from the fact that they have become overcooked and the tissues have somewhat softened and collapsed. When cooked, there was practically no difference in the taste of the samples blanched in the different ways.

Blanching of Cabbage

Cabbage blanched by hot water and hot 2 per cent. salt solution was somewhat more attractive than steam blanched cabbage, but blanching with hot 1 per cent. baking soda solution is much less satisfactory. When cooked, all samples were practically indistinguishable in appearance and taste, except those blanched in 1 per cent. baking soda solution which were slightly off flavor and were a little slimy. The chief difference noted in the samples was that those blanched for the longest periods of time were refreshed more rapidly and more completely when soaked in water.

General Discussion

It is impossible to make definite statements of the exact number of minutes which each product should remain in any particular steam processing chamber in order to be properly blanched. The duration of exposure will depend upon the temperature of the product during exposure, and the farther the temperature lies below 212° F., the longer it will take to inactivate the enzymes and to reach the proper stage of cooking. There are no two steam chambers in which the conditions of temperature are always the same. The tem-

perature in the chamber depends upon the condition and temperature of the steam and upon the rapidity and completeness with which it fills the chamber. The trays containing vegetables are loaded on trucks, the trucks are introduced into the chamber, and steam turned on. The steam is generally admitted in jets from a system of perforated pipes and should quickly fill the chamber. Unless the perforated pipes are properly distributed, however, the blanching in this apparatus is not uniform.

The conveyor type of steam blancher gives if anything more uniform results than the chamber. A conveyor belt in this case carries the trays containing the material through a box-like hood and live steam plays on the products from both above and below. In this case, however, as in the case of the chamber blancher, the number and arrangement of the steam jets and the steam pressure are important. It is not possible, therefore, to give exact times for proper steam blanching, but this time must be determined experimentally for each type of equipment.

Where blanching is accomplished by immersion in hot liquid the temperature of the solution can be more uniformly controlled and more definite statements as to time required can be made. The objection to immersion methods has been the difficulty encountered in spreading the hot blanched material on trays. If this difficulty could be overcome, a more general use of the immersion method could be expected.

Conclusions

I.—Dehydrated products equally as attractive as those prepared by steam blanching can be prepared by blanching by immersion.

II.—Blanching by immersion can be controlled more effectually than steam blanching.

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A Consolidation of
The Chemical Engineer
and Chemical Age



THE United States entered the war not from any humanitarian motives, but to avenge insult to her sovereignty. The political responsibility then inculcated in a foreordained finish now has an equally strong economic analogue.

America's economic sovereignty is degraded, not so much by any dereliction on the part of her producers and traders as by the recalcitrancy of the original culprit to make good to his neighbors the results of his villainy.

Domestic legislation to alleviate our present ills will be futile of the results desired, so long as we acquiesce to the continued insult to our economic sovereignty involved in the denial and refusal of Germany to atone to the limit of her recognized capacity.

The Nation's duty to its unemployed workers can be fulfilled most effectually not by temporizing class legislation or capitulation to class power, but by co-ordinating its influence with that of its ravished Allies to teach Germany that a distressed world shall not suffer further outrage.

The sharpness of our admonition should not be softened unduly by the amenities of diplomacy.

THE longest step toward our economic recuperation will have been taken not when deflation has run its laggard course in every avenue of domestic activity, but when we recognize generally our national dependence upon the good fortune of other nations for our own prosperity and are quick to apply the influence of that knowledge to eliminate the causes of adversity.

Problems of production are solved far in advance of the world's present needs. It is faulty distribution from which we mainly suffer.

With our surpluses of foodstuffs and raw materials and famine and idleness abroad, the responsibility of politicians to facilitate by every practicable means the movement of goods is grounded in their duty to end here the domestic reflection of foreign conditions.

National prosperity no more than that of individuals can be built on adversity.

WE make our own troubles. We violate economic law and wistfully complain of the conditions we create. Distributors by organized price maintenance discourage and restrict the consumption of goods upon which employment is based. Labor likewise clings stubbornly to that to which it is not entitled and brings upon itself the common penalty of distress and by its class advantage denies that equality of opportunity which is the birthright of all.

We live in a welter of economic waste as expressed not so much in production as it is in the crudities and inefficiencies of the exchange of goods and services.

In a world where labor and material gaze idly upon demand that they cannot satisfy because of its sterility, man looks to government to effect fructifying coordination and finds in the clash of controversy only assurance of its maintenance.

COMPARE the pay of teachers of applied science, shown in the table in this issue of CHEMICAL AGE, with that of members of the railroad brotherhoods and contrast their respective benefactions and responsibilities to the Republic.

That a teacher exalted to place and power should encourage the arrogance that now delays and menaces our economic readjustment, may bring to a profession whose highest compensation is the satisfaction of service to others the thought of how finite is capacity and how unwise it is to repose in one man responsibility for decisions whose irrational sentimentality perverted democracy to domination by class.

It is impossible to estimate the retardation to American life and industry involved in political interference, beyond simple, necessary regulation, with our transportation industry.

Not only is the development of our far-flung domain a function of accessibility, and the service of means thereto so intimately related to the resourcefulness of American individualism, that our transportation industry should be permitted the fullest freedom to build, own and operate that it may reflect freely and serve efficiently American industry.

Russia alone provides the only analogy of a great instrumentality created *pari-passu* to serve society, but which by the grace of politics actually distresses it.

THAT a manufacturing concern can not operate at a profit that will provide not only for its present maintenance but for the creation of a surplus to tide over the contingencies of rainy days, is evidence either that its service is not needed or can not be supplied at a price that warrants its existence.

While the concern maintains itself by service to society, by no process of reasoning that contributes constructively to the solution of the great problems of the

common weal can it be said that it exists for the help in their status as a part of society.

The manufacturing concern is created not primarily to give employment but to make money; that it does provide jobs is because the latter process is impossible without labor.

There is no benevolence in business, otherwise there would be no flowering of the purpose of existence as we understand it; nor is the manufacturing plant a humanitarian institution.

It is created and maintained not for the conservation of society but for the conservation of capital which is simply stored-up, crystalized labor made of the highest usefulness and efficiency by organized production to the end of increase and accumulation by operation.

In the present decade the world has witnessed the destruction of capital beyond human imagination. Its replacement is not possible in an atmosphere of fallacy that denies its place in the evolution of civilization.

To exalt a lower form over a higher not only perverts a natural process but in its pernicious results tends to degrade society by retarding and even destroying industry.

WE would not disparage the conservation of human life or belittle the place of altruism in human relations, but we would enforce the conviction that the human element of production, regardless of its position in the general plan, can get only what it earns. An excess compelled by tribute comes only to vex in the general degradation.

Industry is created by ambitious men, under the inspiration of the rewards of enterprise, for the accumulation of capital; and when denied this outlet for their constructive genius there will be no field for human labor.

Class domination of incompetence is at the peril of the hard-won gains of society.

SENATE Bill No. 637 introduced April 13 is entitled "An Act to protect government documents by copyright." Senator Fletcher of Florida, its sponsor, denies knowledge of its parentage other than that it is a hang-over of the Wilson administration.

Obviously this harmless-looking child of a socialistic regime might apply only to private commercial reproductions of government documents as occurred at one time in a copyrighted publication by private parties of a document entitled, "The Lives of the Presidents."

We cannot believe that the scientific bureaus are responsible for this distorted expression of their responsibilities in the educational activities of the government.

It will devolve upon their respective heads to disclaim any contact with this anomaly, and also upon Senator Fletcher to let it lay in undisturbed obscurity.

IN the current contribution to the consideration of the project of an economic organization of chemists, a challenge is made to the initiative of progressive chemists in every chemical center in the United States to organize, as has the New Jersey Chemical Society, in their respective environment or state, the American Institute of Chemistry.

Nominations of leaders were made to guide the educated chemical workers in every department of the industry in an organization designed to make the most out of its members by making the most out of the industry.

Never before have so many chemists walked the streets, or sought the seclusion of libraries in the humiliation of unemployment. The spectacle of men who have devoted their lives unto maturity in preparation for professional work in the fundamental industry being sacrificed on the altar of adjustment, demands organized study of an indispensable human factor in industry; to which is called the teaching chemist, the production chemist and the business chemist—to the end that there may be developed a degree of adaptability, a knowledge of opportunity and an interchange of helpfulness, expressed in an organization to which chemically educated men can turn as a matter of right for service rendered as a matter of duty.

WHAT chemist of middle-age today wants or is able to spend \$5,000 on his boy to undergo the hit-or-miss experience that he himself underwent? Present industrial conditions in the utilization of high-class human material is an example of crudity that in many cases can be characterized as human as well as economic waste.

What the successful industrial chemist wants and will encourage is an organization composed in its governing element of the teaching chemist, the production chemist and the business chemist, that will not only constitute a bridge from the institution to industry, but will cultivate in its membership a solidarity and instinct for service of wide potentialities both to the individual and to the industry.

Such an organization not only does not duplicate any existing service but will supply a service of the highest practical usefulness and of a type ignored by existing organizations. This organization will be conceived in a need and will grow from the bottom up and not from the top down, until older men see that it is successful when coalescence will be from all quarters.

The development of the chemist's relationship to industry embraces his responsibility to his fellows; not that the other fellow can be helped, but that in the process we can help ourselves.

Notes on Early Industrial Chemical History in Philadelphia

By Samuel P. Sadtler, Ph.D., LL.D.

Emeritus Professor of Chemistry, Philadelphia College of Pharmacy and Science

THE centennial celebration of the founding of the first college of pharmacy in the world, the Philadelphia College of Pharmacy and Science, on February 23, 1921, embraced not only the commemoration of an important event in the history of American chemical industry, but the apotheosis of the influence of the apothecary in the development of the science and art of chemistry.

Many men prominent in chemical enterprise met to do homage to inspiring tradition and to felicitate those whose responsibilities are a heritage of those influenced by this historic institution. A comparison of the economics, science and social conditions of one hundred years ago, particularly as they relate to chemical enterprise in its pharmacal aspects, with those existing today, was made in numerous addresses.

The early prominence of the chemical industry in Philadelphia persists today, to which growth, both locally and nationally, the Philadelphia College of Pharmacy has contributed much. Local pride in a home institution of national influence in applied chemistry encourage the presentation of a few notes on early industrial chemical history in Philadelphia.

First Manufacturer of Chemicals in America

Probably the first to inaugurate the manufacture of chemicals as such in this country was the firm of Christopher, Jr., and Charles Marshall, sons and successors of Christopher Marshall, an early druggist and one of the original "fighting Quakers" of Philadelphia. This firm had, as early as 1786, entered quite extensively into the business of making muriate of ammonia and Glauber's salt. The factory is described by Watson, in his "Annals of Philadelphia," as being a grim and forbidding-looking building on Third street, near the stone bridge over the Cohocksink Creek. This firm is said to have developed an annual output of upwards of 6,000 lbs. of muriate of ammonia; quite an achievement for that time.

Sulphuric Acid

Let us now take up the beginnings of the manufacture in Philadelphia of one of the fundamentally important chemicals, viz, sulphuric acid. This substance is recognized as the basis of all chemical industries and its manufacture must precede that of most other chemicals. The theory of the lead-chamber process already was understood by chemists, by the middle of the eighteenth century. Ward had made sulphuric acid in England in 1740 on a large scale in glass vessels, and Dr. Roebuck first used leaden chambers instead of glass in Birmingham in 1746. The first leaden chamber was erected in France, at Rouen, in 1766.



SAMUEL P. SADTLER, Ph.D., LL.D.
Emeritus Professor of Chemistry,
Philadelphia College of Pharmacy and Science.

John Harrison, son of Thomas Harrison, a member of the Society of Friends, was an early Philadelphia druggist who had completed his education by spending two years in Europe, in part under the instruction of Dr. Joseph Priestley. Upon his return he began, in 1793, the manufacture in Philadelphia of various chemicals, and notably of sulphuric acid. He had at first a lead chamber capable of producing 300 carboys of acid per annum, and his laboratory at this time was on the north side of Green street, west of Third.

In 1804, he established a new factory at Second and Huntingdon streets, near Frankford road, Kensington, but continued for a time the work on Green street. In 1807, he built what was for that time quite a large lead chamber; it was 50 feet long, 18 feet wide, and 18 feet high, and capable of making nearly 500,000 lbs. of sulphuric acid annually, the price of which was then as high as 15 cents per lb.

As is well known, acid produced in lead chambers is not the oil of

vitriol of commerce, and the only method known at that time to concentrate it to the required strength was by boiling it in glass retorts—a very precarious and dangerous process. The constant breakage of the glass largely increased the cost of the concentrated acid and the danger of the work. To obviate this great trouble, Mr. Harrison, in 1814, introduced the use of platinum for the manufacture of sulphuric acid, for the first time, at least in this country.

In the previous year, 1813, Dr. Eric Bollman, a Dane, had come to Philadelphia. Dr. Bollman was familiar with the metallurgy of platinum, and a highly scientific man. He brought with him from France Dr. Wollaston's method for converting the crude grains of platinum into bars and sheets. About the first use that Dr. Bollman made of these platinum sheets was the construction early in 1814, of a still for the concentration of sulphuric acid for the Harrison works. It weighed 700 oz., had a capacity of 25 gallons, and was in continuous use for fifteen years.

This early application of platinum for such purposes was highly characteristic of the sagacity and ingenuity of the American manufacturer. At the time the use of this rare metal was a novelty in Europe and known only to a few persons and certainly entirely unknown in this country. It follows, therefore, that John Harrison was not only the earliest successful manufacturer of sulphuric acid in America, but the first in this country to concentrate it in platinum.

Farr and Kunzi were next in Philadelphia to follow the lead of Harrison in making sulphuric acid, which it is stated they did in 1812, and shortly thereafter Wetherill & Bros. also began the manufacture of sul-

phuric acid on the east bank of the Schuylkill River. Chas. Lennig, the founder of the present firm of Chas. Lennig & Co., Inc., also began the manufacture of sulphuric acid in 1829, and Rosengarten & Sons shortly thereafter. Carter & Scattergood in 1834 also were early manufacturers of sulphuric acid.

Nitric acid, under the name of *aqua fortis*, is mentioned in Scharf & Westcott's "History of Philadelphia" as made by Christopher Marshall, Jr., a Philadelphia druggist, at the close of the last century. A communication from Thos. Skelton Harrison says his grandfather, John Harrison, began to make nitric and muriatic acids in 1804. Carter & Scattergood had it on their list of manufactures in 1834. Muriatic acid also is mentioned as made by this latter firm in the year 1834, as were tartaric acid and citric acid.

Paint Pigments

The first white lead factory of Samuel Wetherill & Sons was built in 1804 at the corner of Broad and Chestnut streets, but it was burned down a few years later, and in 1808, they erected a new factory at Twelfth and Cherry streets.

His son, Samuel Wetherill, Jr., was the active man of the concern, and assisted his father in all business matters. Their enforced experience during the Revolution concentrated their attention upon the manufacture and sale of chemicals and they went into the drug business. In 1785, Samuel Wetherill & Son were located in Front street, above Arch. Here, for many years, "Wetherill's Drug Store" was an old landmark and the place at which sons and grandsons were brought up to the business. The Wetherills were the pioneers in the manufacture of white lead. They established it before the year 1790. They erected extensive white lead works near Twelfth and Cherry streets, which were burnt down in 1813, but afterwards rebuilt.

The fire which destroyed the white lead works proved to be incendiary and started by a young English officer the day before he sailed for Europe.

In October, 1811, Samuel Wetherill, Jr., obtained patents for a new mode of washing white lead and for screening and separating metallic from corroded lead in the process of making red lead. This method has been adopted generally by all makers of lead.

"The name of the first white lead firm was Samuel Wetherill & Son, Samuel Wetherill, Jr., evidently being the active member. After his father's death in 1816, Samuel Wetherill, Jr.'s, sons joined the business and the firm became Samuel Wetherill & Sons. After the death of Samuel Wetherill, Jr., in 1829, it became Wetherill Brothers. The store of the firm was at 65 North Front street; the warehouse and mill of the old establishment were on Coomb's alley, back of Second street.

"When the residence part of the city spread to Twelfth and Cherry streets, Samuel Wetherill having bought ten acres of land on the banks of the Schuylkill River, below Chestnut street, moved there in 1847; his sons (Wetherill & Bro.) built the white lead and chemical works and continue to this day."

John Harrison also began the manufacture of white lead in 1806. The firm of Mordecai & Samuel N. Lewis, which afterwards became John T. Lewis & Bros., also began the manufacture of white lead in 1812, making three Philadelphia firms manufacturing paint colors at that time. These three earliest manufacturers of white lead and paint colors or their lineal successors have continued in business to the present

time, for considerably over a century, and have done much to give Philadelphia its long-continued prominence as a chemical manufacturing center.

One of the lines of manufacture that contributed to make Philadelphia a great chemical center early in the last century was that of the yellow and red prussiates of potash. I have been furnished a private memorandum concerning the activities of the firm which began this industry and was active in it for many years.

"Under the firm name of Carter & Scattergood, a profitable chemical manufacturing business was conducted from 1834 to 1911; and was absorbed in the latter year by The Henry Bower Chemical Mfg. Co.

"John Carter and Joseph Scattergood (graduated 1829, Phila. Coll. of Pharm.) bought out the old-established business of 'John & Daniel Elliott' founded in 1754 by their grandfather, John Elliott.

"The Elliotts' place of business and factory originally was on Front street, between Chestnut and Walnut streets, but in 1812 the manufacturing work was transferred to a new factory which they erected at Nineteenth and Pine streets, John Carter becoming their apprentice, January 1, 1816.

"The list of chemicals produced by Carter & Scattergood was an extensive one, John Carter being the manufacturer and Joseph Scattergood the business man of the concern. It included citric, tartaric, oxalic, nitric and sulphuric acids, bichromate and prussiates of potash and many other articles, but their operations during the first ten years of their business were on a scale which in this day would be considered quite small.

"Yellow prussiate of potash was first made by them in 1834, this being, so far as known, the first production of the article in America, but the demand was very small, only 472 lbs. being absorbed by the market in that year. In 1835, the sales increased to 6,443 lbs., but it was not until 1843 that the demand became large, the sales amounting in that year to 69,470 lbs. and rapidly increasing in the next two years, the sales in 1845 being 207,522 lbs.

"The high price, over 50 cents per lb., and the keen demand, of course, resulted in active competition, and the market for many years was over-supplied.

"In the year 1846, Carter & Scattergood began to produce red prussiate of potash, being the first in America. This was a highly profitable branch of the business until the introduction of coal-tar dyes, as substitutes for prussiate colors on woollen goods gradually displaced it in the most important field of consumption. Except for the manufacture of blue-print paper, there is now very little demand for it."

Potash and ammonia alums were first made in Philadelphia by Chas. Lenning in 1837 and by Harrison Bros. in 1840.

Pharmaceuticals

Coming now to the early manufacture of medicinal or pharmaceutical chemicals which long has made Philadelphia famous, we find that George D. Rosengarten and Charles Zeitler, as Rosengarten & Zeitler, began the manufacture of chemicals in St. John street, Philadelphia, about 1822. They were the first to manufacture the alkaloids of cinchona and opium in this country, having begun the manufacture of sulphate of quinine in 1823, of sulphate of morphine in 1832, and strychnine in 1834. The salts of quinine were also manufactured by John Farr in 1825.

These two firms and their successors have had much

to do with the establishment of Philadelphia as a chemical manufacturing center. After the withdrawal of Mr. Zeitler, which took place within a year, Mr. Rosengarten continued alone, later taking in a Mr. Dennis. When this partner withdrew some twenty years later, the firm became Rosengarten & Sons, which business continued until the formation of the present combination with the other large Philadelphia manufacturer of medicinal chemicals, Powers & Weightman.

Farr & Kunzi began the manufacture of chemicals about 1818. Abraham Kunzi, a Swiss by birth, retired in 1838, and the senior partner, John Farr, who had been born and brought up in England, associated with himself Thomas H. Powers and William Weightman, two young Philadelphians, who had been in the employ of the firm for some time. The new firm name was John Farr & Co. This was later changed to Farr, Powers & Weightman, and on the death of the senior partner in 1841, the firm name was again changed—this time to the title, Powers & Weightman, by which it was so long known throughout the entire country.

These two firms, in 1905, united under the name of the Powers-Weightman-Rosengarten Co., and continue as probably the best-known manufacturers of general and medicinal chemicals in the United States.

Glycerin

The history of the commercial production of pure glycerin is also of interest in this account of Philadelphia's chemical achievements.

The late Robert Shoemaker, while making medicinal plaster, had his attention directed by Professor William Proctor to the residuum liquid which was obtained. From this he prepared the first glycerin made in this city, if not in America, in 1846, and this was exhibited by Professor Proctor to his class at the Philadelphia College of Pharmacy at that time. Mr. Shoemaker manufactured it for sale, according to his statement, for some years in connection with the manufacture of lead plaster.

The later development of the refining of waste-lyes containing glycerin also was a Philadelphia achievement, and was worked out by the late Henry Bower. By the courtesy of his son, Mr. W. H. Bower, I am allowed to quote from a private letter, which gives the account of his work, in his own words:

"Quite early in life, say in 1857, my attention was keenly directed to some mode of purifying these waste liquors of the stearine candle factories, and in that year I could have purchased the entire product of crude glycerine of the United States for a sum not exceeding \$5,000, although the manufacture of it was nearly if not quite as large then, as now.

"I commenced work in earnest to experiment in purifying glycerine in 1858—and expended long and weary efforts, all my earnings, as well as some borrowed money. I at first succeeded in producing an article sufficiently pure for use in gas meters (in place of alcohol) to prevent freezing and stoppage of the instrument—it was not, however, until about the middle of 1860 that I succeeded in making and placing in the market a 'pure inodorous glycerine,' even then the amount sold was quite insignificant. Inferior grades made their appearance about the same time in the West. The bland and neutral nature of the article, and the discovery of various uses for it, soon increased the demand to a marked extent; I was enabled from time to time to increase my works, and in increasing them was making steady inroad into the supply of the crude article. At this period, say in 1863, the business of refining glycerine was scarcely known on the continent of Europe, and I exported small quantities to Hamburg, paying a profit; Belgium, France, Germany and Austria were immense producers of crude glycerine, but like its sister product here in previous years, it only found its way to the sea. As before stated, the use and sale of the refined continued to improve, the crude growing more scarce each season, until a point has been reached when every available pound is worked into a valuable product. It would not be out of the way to place the

total value of all the glycerine sold in the United States at this time at \$500,000. This sum could never have been reached had it not been for the discovery of a mode for refining, to which, so far as this country is concerned, I lay claim; by a careful management of my business for some years I kept the process a secret; but in time some portions of it came to the knowledge of other persons, who have been enabled to produce very fair articles. There are besides myself, here, two refiners in Cincinnati, one in Chicago, and one in New York."

There were, of course, other drug and chemical firms who were well and favorably known in the early half as well as the later half of the nineteenth century.

We have already mentioned the name of Christopher Marshall, Jr., who was active in Revolutionary days. Himself the son of a druggist, he was succeeded by his son, Charles Marshall, and his grandson, Charles Marshall, Jr., who in 1814, established himself in the wholesale business at 310 Market street.

With this Charles Marshall, Jr., entered as an apprentice, George W. Carpenter, who later became one of the most prominent as well as successful of wholesale druggists in Philadelphia. The old store of Carpenter & Henszey, at Eighth and Market streets, I remember quite well as it stood about forty years ago.

A very well-known drug firm of the latter half of the nineteenth century was that of Bullock & Crenshaw. They were the successors to Smith & Hodgson, who established themselves as druggists at the corner of Sixth and Arch streets in 1819, where they continued until 1849, when they disposed of their drug business to two of their employees, who then formed the firm of Bullock & Crenshaw. This firm carried on not only a wholesale drug business, but handled fine chemicals and chemical apparatus, supplying many colleges and schools throughout the country. In September, 1868, they moved to 528 Arch street, where in larger quarters they carried on a flourishing business until the death of Charles Bullock, the surviving partner.

The firm of French, Richards & Co. was for many years one of the best known of Philadelphia drug firms at its centrally located store, Tenth and Market streets. The founder of this firm was Clayton French, who, in 1840, entered the drug business as an apprentice with Dr. Edward S. Wilcox. This firm was disbanded in 1890 on the death of its founder, but in the meantime its extensive cement and plaster department, which was started in 1852 at Callowhill street and York avenue, was transformed in 1883 into a separate business under the name of Samuel H. French & Co. This has since developed into a very extensive cement, plaster and dry color firm, now under the leadership of Howard B. French, a son of Samuel H. French, of the original French, Richards & Co. firm.

Mathieson Alkali Works, Inc.

The Mathieson Alkali Works, Inc., 25 West 43d St., New York, spent \$221,069 in 1920 on its Niagara Falls plant, largely for a brine purification system. Expenditures on the Saltville plant aggregated \$256,411; 25 per cent. for a new boiler installation, which will be completed in 1922. The By-Products plant, which cost about \$950,000, is laying idle because of the failure of stockholders to ratify an arrangement with the Durex Chemical Corp., whereby profitable use for the plant could be found. The Niagara Falls and Saltville plants are now, owing to the general depression, being operated at respectively 30 and 25 per cent. capacity. Elimination of sales agents in marketing the company's products, effected early in 1920, while it has increased by 25 per cent. the average sale prices per ton, has necessitated an increase of working capital.

Selling Safety in the Factory

By H. T. Martin

Manager, Health and Safety Department, The Fisk Rubber Company

THE greatest results will be attained in accident prevention work in the factory when the safety habit has been sold to every employee.

The accident reduction problem is one of salesmanship and must be dealt with accordingly. There are always three things of vital importance in any selling campaign, viz. (1) the article for sale must have merit, (2) the sales force must be organized to the highest point of efficiency, and (3) the advertising connected with it must be the very best possible.

The article for sale in this instance is the safety habit, and there can be no question about the merit of the goods.

Sales Organization

Before we go far into the details of organization we must have a sales manager. The logical man for this job is the factory manager. Let us look him over. If he is not qualified for the position it would be better not to fill it at all. He must make good or the whole plan will fail. He must be sincere, have plenty of backbone and pep and be willing to spend some of the company's money to make the plant mechanically safe. Assuming that he has these qualifications, he is made sales manager. This fact should be given considerable publicity. It pays to have every member of the factory organization familiar with the fact that the manager is heart and soul for safety.

In looking over the field for a sales force, we find the foremen particularly adapted because of their relationship with people with whom we are going to do business. The workman judges the company by the foreman with whom he comes in daily contact, and will listen to him as to no one else. The foremen, therefore, have long lists of prospective customers. They are intelligent, and when they once realize their responsibility in connection with this selling campaign, they will sell effectively and are, therefore, engaged. At a series of meetings called by our Safety Sales Manager, these men are instructed about their new duties and advised of methods to be used in order to become efficient safety salesmen, which is essential if they expect to remain on the payroll. They should be put to work immediately in their respective departments.

It is not always possible for the foreman in a large department to get the desired personal contact with the worker, and of course ultimately it is the worker we must reach. In such cases the work of selling the safety habit must be delegated to an assistant, the foreman becoming an assistant sales manager and his subordinate the salesmen. These men should receive preliminary instructions similar to those given to the foremen from the Sales Manager, and frequent conferences of members of the sales force should be held for the exchange of ideas. There must be no lost force to the selling talk, even though it is transmitted two or three times. Such an organization cannot help being efficient if the boss insists that the men show results. Accident records will soon show where the weak spots are, and they should be strengthened at once, even though the extreme measures of removal have to be resorted to. The movement is contagious. Volunteer salesmen from within the ranks almost invariably join the forces and work with a will. This is highly desirable and should be encouraged in every possible way.

Up to the point of sending the salesmen into the field, the Safety Department has acted in an advisory and statistical capacity only; but when the sales force is organized and on the job, the Safety Department becomes also the Advertising Department and assumes responsibility for snappy safety advertising which will be of real assistance to the sales force, keeping the subject alive and reaching not only the foreman but the workmen as well.

The Safety Advertising Manager must be a thoroughly human individual, capable of gaining the confidence of the several types of men with whom he must mix. He will get co-operation if he knows how, and he must have it to succeed.

The Safety Department must keep the foremen posted on results they are securing, and give them every possible assistance by studying conditions and making known to them everything which has any bearing on their accident records.

Sales Methods

Further work must be done by the Safety Advertising Department which will reach the worker direct. Safety departments in various concerns as a general thing find it very difficult to put over a new idea. Generally some one else has used and discarded the same thing. The advertising must not be permitted to become stale, changes being made frequently in order that the subject may be of interest. Some of the methods used to assist the foremen in their selling campaign are described in the following paragraphs:

The House Organ

Many concerns issue periodically pamphlets devoted to safety, giving accounts of recent accidents within the plant, and material of a general nature. However, it has been found that a far more valuable method of driving home the gospel of safety is through the factory house organ. This paper contains many items of interest and is invariably taken home, so that in cases where a certain space is devoted to safety propaganda it is difficult to avoid those articles. The fact that other members of the family are made familiar with this reading matter means that more pressure is brought to bear upon the man we are trying so hard to impress, by someone to whom he may be more willing to listen.

The Movies

We all appreciate the value of motion pictures in safety work. Many of the larger concerns have prepared films which are interesting as well as instructive and are taken seriously by many who pay no attention to other kinds of safety propaganda. In some cases it is not practicable to make films of this description, but where they can be used they are always effective.

Meetings

Safety meetings for the workmen may be held at infrequent intervals to great advantage. However, these meetings are made as short and snappy as possible and are planned to make the men feel that they have an actual part in the whole affair. They are sometimes held away from the plant on the men's time, and in that case arrangements are made to give them as good a time as possible. Safety meetings held at the plant on the company's time can best be confined to subjects

interesting the particular department for which the meeting is held.

Rule Book

Instead of the cumbersome rule book which is often given to the new employee in many concerns, a departmental safety rule book has been published which deals with the operations in a single department only. In that way the individual about to enter upon a new position can easily familiarize himself with the rules pertaining to the operation at which he will work. This subject is important and gives the foreman the kind of backing he needs in the event that it becomes necessary for him to insist upon a strict adherence to some of the simple rules mapped out for the prevention of accidents which are common in his department. It is advisable always to have the foreman draw up these rules, with the assistance of the Safety Department.

No-Accident Day

One of the best ways of reaching the man on the job is to designate some definite date as No-Accident Day, to advertise this day in every way possible by special notices, special literature and bulletins, rallies or meetings, by erecting a large scoreboard, tagging every man in the organization with a tag suitably inscribed, and to see to it that all of the workers understand the meaning of the tag and the idea.

It is advisable in events of this kind to count as an accident only those which result in the loss of time. To do otherwise may prove detrimental, because the desire on the part of some not to mar the record may keep them away from the Hospital for some slight injury, the neglect of which might prove serious. This plan guarantees action and a real drive for safety for the time specified at least, and the after effect is very beneficial. These days may be repeated with variations, such as following with a tagless day after a reasonable interval. After a date has been selected, the foreman may be made responsible for the passing of information down the line without the assistance of tags.

Safety Contests

Safety Contests are sometimes used with success. The spirit of contest is in us all, whether it be baseball, pie-eating, or accident prevention. All that is needed is the necessary stimulation. Plants, departments or units may be pitted against each other in contest for a specified time.

In one instance, a contest was held between two departments with about the same degree of hazard existing and the same number of employees, where there was at stake something in which both factions could participate, such as a theatre party or picnic. Each employee made a small deposit, the money to be refunded to the winning department, and the money of the losers, together with some of the company's money, to be used in defraying the expenses connected with the event. This proved to be a big success, arousing the personal interest of each individual, and has been worked out along similar lines several times since. Care should be taken to keep the deposit so low that no one will be hurt financially, and extremely close supervision should be exercised to guard against the neglect of minor injuries.

Inspection Committee

In some plants it is considered advisable to give the workmen an active part in the accident prevention program by placing them on inspection committees, serving for an interval usually of one month, at which time

the committees change, retaining one member as chairman of the new committee. There is a variety of opinions as to the merit of such committees. It is a fact, of course, that by actually engaging in the work they may take more interest, while it is equally true that a great percentage of items reported by such committees are of trivial nature and refer to other than humanitarian errors which they seem to overlook.

Direct Contact

A means of direct contact which should not be overlooked can well be carried on by the factory doctor, safety man, the man paying compensation insurance, and the visiting nurse. These people, coming in contact with the man who has received an injury, find him in a most receptive mood, and it generally follows that he returns to work a 100 per cent. safety salesman. After he has been through the mill he can well describe to his fellow workers some of the trials and tribulations of a man who is forced to remain away from his work because of injury.

Investigation

A court of inquiry on all serious accidents, conducted by the factory manager, has the effect of keeping all foremen and departmental heads on their toes, as no one is anxious to accept the responsibility of a serious injury to his fellow man.

A pretty good slogan for this advertising campaign would be "Tell it to them quick, and tell it to them often." The workman can easily grasp one thing at a time, but in order to make a deep impression on him, an idea must be kept constantly before him.

Significance of Safety

The entire safety movement is still in its infancy. The efforts for preventing accidents are not confined to industry, but are being carried into every walk of life, until, everyone realizing the enormous unnecessary loss of life and crippling of men and women, forms habits of safety which will reduce accidents to a minimum, and so we urge every thinking man and woman of America to join the ranks of salesmen who are trying to make this world a safer place in which to live.

Secretary of War Weeks announces that he will recommend the appropriation of the additional \$30,000,000 required to complete the Muscle Shoals, Ala., water-power project, if any industrial organization will guarantee the Government a fair return on its total investment in the hydro-electric power and nitrogen fixation plants.

* * *

The Western Electric Company now stages an annual products show at its plant at Hawthorne near Chicago in an attempt to show its workers the why and wherefore of everything they do. Every type of machinery used in the factory and every item produced in it are displayed in pieces, partially assembled, and assembled and explained by demonstrators. Thousands of employes visit the show with their families and department heads conduct their own workers through it. The company is anxious to develop active inquiring brains in its employes. With more than 20,000 workers engaged in more or less specialized work at Hawthorne and spread out through more than seventy-five acres of buildings it is obvious that very few individuals in the course of their work have a chance to get a knowledge of the plant as a whole. To offset this condition the company arranges an exhibit of all its processes and products each year.

Status of the English Consulting Chemist

Abstract of Annual Address of Alfred Smetham

President of "The Society of Public Analysts and other Analytical Chemists"

THE Society of Public Analysts of Great Britain antedates in its nearly 50 years of service, the organization of its American congener, the Association of Official Agricultural Chemists, by about 12 years. The personnel of the latter Association is exclusively those engaged in analytical work in the service of our federal and state governments. Its English analogue, under its original title, embraced in its membership not only the government analyst but the private consulting or analytical chemist. In comment on a situation arising from the use of a title for an organization not borne out by the character of its membership, Alfred Smetham, president of "The Society of Public Analysts and Other Analytical Chemists," says in effect:

"The original title of the Society of Public Analysts has become so widely known and respected that in many ways it seems a pity to hide its identity under a new title; but as the term, "public analyst," is limited by Act of Parliament to those analysts appointed under the Food and Drugs Act—and cannot, therefore, be appropriated by practicing analysts generally—there seems no alternative but to change the name or continue as at present. Doubtless some happy solution of the problem will be evolved, but of the suggestions hitherto made none seem quite to meet my æsthetic taste. There is a crispness about our original title which seems to arrest the attention at once.

"The fact that the proportion of analysts other than public analysts has been steadily increasing renders the alteration in the title, if it is to be descriptive of the objects of the Society, the more necessary, and as the number of public analysts is practically stationary, while the analysts engaged in general practice and in connection with trade and manufactures are steadily increasing, and, with returning trade and prosperity, are bound to increase rapidly, it seems to me that if the alteration in title is necessary or desirable the present is the opportune time to make it

Retrospect of the Consulting Analytical Chemist

"I have said that the proportion of analysts other than public analysts is in the future likely to increase at a rapid rate, and I am basing the statement on a careful observation of commercial and manufacturing conditions for a period of over 40 years. When I went into practice my work consisted for the most part of analyses to assist in the control of manufacturing processes, or to help purchasers to make a selection of produce sold practically on a flat rate; and very few of the analyses were sent under contracts, the price to be decided by the contents of the valuable constituent or constituents, as the case might be.

"As the years went on and the rule of thumb in manufactures was replaced by more scientific control, purchasers insisted on safeguards, especially when buying forward, and by gradual evolution, in nearly every branch of industry. Safeguards in contracts are inserted, and in many instances these safeguards take the form of restrictions based upon analytical control.

"Concurrently with the altered conditions in manufacturing methods, and the greater demand for more definite specifications with regard to quality, especially when the goods in question have been bought to arrive,

the demand has arisen for increasing the safeguards against any inferiority in the produce which may be tendered in fulfilment of a contract.

"This desire on the part of the more progressive merchants and manufacturers has brought into existence a considerable number of combinations of diverse interests, who, forming themselves into associations representing their respective trades or businesses, have generally controlled the transactions, especially in the case of our overseas trade. Each year sees the framing of innumerable new contract forms, and in the modification of old ones, and with the increase in the stringency of the demands on the part of buyers there has been necessarily an increase in the volumes of work falling to the lot of analysts in general.

Growth of Dependence Upon the Chemist

"If I read the signs of the time aught it seems to me that the tide having begun to flow in this direction it will continue to do so until a high-water mark has been reached and practically the whole of our commerce brought under scientific control. The employment of men of exceptional talent by companies and associations for the pursuit of pure research, in contradistinction to the control of manufacturing processes or business transactions, is evidence sufficient to indicate that our leaders of commerce and industry are rapidly realizing, thanks partly to work done by chemists and other scientists during the war, that research work is not only a necessary adjunct to a successful business enterprise, but is at the same time a highly profitable investment.

"I am glad to see this tendency on the part of leading business men to call to their assistance the best brains of our profession, because it must inevitably have a leavening effect on the general mass of business men who, in the past, have regarded chemists, not as a necessary controlling influence in the factory or in business, but as an unavoidable adjunct to the business side of their concerns.

"The admirable work done during the war by so many members of our profession, both at home and abroad, and the important part played by the investigations and work of our chemists in finally winning the war, have brought home to the nation at large the immense importance and possibilities of chemistry, not only in fostering the interests of our own industries, but in advancing the cause of civilization the world over.

"That the ever-increasing developments of chemistry should have been so directed as to have caused such world-wide havoc is greatly to be deplored, and it is to be hoped that the effects produced and the lessons learned will have throughout the ages the effect of teaching future generations the folly of diverting our beloved science from the arts of peace to those of war.

Analytical Routine

"But to revert to my theme. The formation of the numerous bodies and associations, which I have referred to, has increased the volume of analytical work largely, and to that extent it is a good thing for the profession generally, but as the effect, so far as the commercial side of our work is concerned, is to in-

crease the number of analyses of a similar nature there is a tendency to render a good deal of our work tedious and to some extent monotonous.

"In the nature of things such a result is almost inevitable, as with greater proficiency and greater experience in any particular direction the confidence of one's clients in one's work is sure to grow and, snowball-like, the volume of work is sure to increase, and thus the routine of the laboratory is too apt to assume the functions of something approaching a factory rather than the purely investigational work which we usually associate with a scientific laboratory.

"In this respect, however, we are not far removed from the specialists in medicine or surgery who, after a long preliminary training, find themselves in the heyday of their prosperity dealing with special cases day in and day out.

There is, of course, in addition to the purely routine side of a practice, a considerable amount of work of a highly technical and exceedingly interesting nature which breaks the monotony of life and gives a zest to one's daily occupation.

"The point which I am aiming to make clear is that, although the tendency of the age is to make specialists of us all, care must be taken to found that specialization upon a sound scientific basis, and to avoid drifting into mere machines in controlling a limited section of trade or industry.

Cut-Rates in Chemical Analysis

"Up to the present the policy of the trade associations has been almost universally to entrust the analytical work to trained chemists who have won the confidence of the public; and I think it will be a bad day for the trades concerned and for our profession if, as has been proposed in some cases and adopted in others, analysts are appointed at fixed salaries, or inadequate fees, to undertake the work of the associations I have referred to.

"The question of professional fees, and the remuneration of chemists in general, is a somewhat complicated one, and there does not seem to be any way in which one or the other can be standardized.

"With regard to the fees charged by practising analysts, I think it will be generally agreed that before the war the charges made, even by leading men, were in many directions quite inadequate. This was partly due to a keen competition among chemists for what little outside analytical work was required in the earlier days, when the analyses were required for private information or control purposes. In some cases the fees were cut by men who had been inadequately trained, but as often no very great degree of accuracy was required, and very little opportunity was afforded of checking the results, there was no elimination of the least capable, and the competition of these with the better-trained men kept fees at a low level.

"In this way in many branches of work fees became more or less fixed, and by a general understanding they had to be accepted, especially by the younger members of the profession. Once fixed for any particular analysis it was very difficult for the individual to raise the fees without the risk of losing the work altogether. Thus it happened, in my case at all events, that a very considerable part of my practice was carried on at very little profit to myself.

Compensation of Consultants

"With the altered conditions brought about as the result of the war, it became imperative that a revision

of fees should be made, and even the most altruistic of us were compelled by the force of necessity to raise our fees. The Institute of Chemistry made inquiry into the matter, and in the February number of the *Journal and Proceedings of the Institute* for 1920, stated that, as the result of their investigations, 'the Council are of opinion that Fellows and Associates are justified in making a corresponding increase in their fees for professional services.'

"Although unable to recommend any definite rate of increase over pre-war rates, the Council of the Institute state that an increase of 50 per cent. cannot be regarded as excessive, while some practitioners have doubled their fees. This practically is the attitude which I myself have taken, readjusting the fees according to the work involved, but it is a matter of doubt whether the increases made in the fees cover the extra costs involved under present conditions.

"With regard to chemists employed in whole-time engagements, I am afraid that in many instances the increases in remuneration have not been commensurate with the enhanced value of their services and the extra cost of living; but it is to be hoped that with the efflux of time and the stabilization of the exchanges, the burdens at present borne will gradually be removed, and adjustments made which will remedy the present hardships."

The Chemical Alliance, Inc., in the World War

The Chemical Alliance, Inc., is the outgrowth of a chemicals committee formed early in April, 1917, under the Raw Materials Division of the Council of National Defence, which was organized in pursuance of a provision in the Army Appropriation Act, approved August 29, 1916.

Under portents of national disaster in absence of adequate preparedness, this committee rapidly expanded, with the assumption of numerous specialized duties, to embrace entire control of the production activities of the chemical industry needful for the prosecution of war.

The Chemical Alliance, Inc., was organized in July, 1917, under the laws of the State of Connecticut, its officers and directors being members of the Chemical Committee, and to which corporation the activities of the Chemicals Committee were transferred, December 4, 1917.

In an 82-page 6x9 book tastefully bound in blue cloth, the Chemical Alliance, Inc., submits an historical review of its object, organization and activities in the fateful 18 months of 1917-1918, which has been compiled at the request of the Historical Bureau of the General Staff, U. S. War Department.

This brief history is notable in that it constitutes of roster of the administrative chemists actively identified with the mobilization of our National chemical resources during the war. With the signing of the Armistice and the return of martial activity to peacetime production, the service of The Chemical Alliance, Inc., was discontinued, but its charter has been retained.

Celluloid Co., 30 Washington place, New York, with a 28-acre plant at Newark, N. J., during the past ten years has expended \$476,365 in research work in domestic camphor tree cultivation.

Preparation of Sweet Potato Sirup

By H. C. Gore

Chemist in Charge, Fruit and Vegetable Utilization Laboratory
Bureau of Chemistry, U. S. Department of Agriculture

A NEW food use for the sweet potato is highly desirable. In favorable growing seasons our Southern sweet potato crop overgrows production often as much as 40 per cent. of its volume of over-size potatoes. Such stock is now of little commercial value, as Northern markets and also sweet potato canners prefer the standard market sizes. On February 12, 1919, the Bureau of Chemistry published in the *Weekly News Letter* of the Department a description of the preparation of sirup from sweet potatoes through the use of malt. The method there described has later been considerably improved through overcoming certain difficulties in the preparation of a well-flavored sirup. One of the most interesting developments was the discovery* that the sweet potato itself contains far more than sufficient diastase to digest its own starch. However, the best results in sirup-making are obtained by the use of a small proportion of malt made from barley or wheat. The latest modifications of the method of production of sirup from sweet potatoes are described below.

Outline of Procedure

Boiling sweet potatoes until soft, stirring until they form a smooth pulp, adding water, and bringing to the proper temperature, put the material in such condition that, by adding a very small proportion of malt and letting the mash stand for a short time, nearly all of the starch of sweet potatoes becomes converted into the soluble carbohydrates, maltose sugar and dextrin. On pressing, the wort containing these soluble solids, together with the sucrose and reducing sugars originally present in the sweet potatoes, easily can be separated from the pomace.

An amber-colored, slightly turbid, sweet sirup with a faint, distinctive flavor is produced on evaporating. While not as sweet as maple or cane sirups, it is sweet enough for many uses. The yield of sirup is roughly one-third of the weight of the sweet potatoes. The ease with which sirup can be prepared, its excellent quality and the good yield make it one of the most attractive products obtained from the sweet potato. Although the method of preparation is so simple, certain precautions are necessary to insure good quality, as in the case of all food products.

Selection of Sweet Potatoes

The principal commercial varieties of sweet potatoes have been tested and found equally good for sirup-making, as judged by yield and flavor of sirup. In general, white varieties like Southern Queen give lighter colored sirups than such varieties as Porto Rico, but the differences are less than would be expected from the differences in the color of the flesh of the potatoes. Both freshly harvested and stored sweet potatoes have been used with equally good results. Undersized roots and jumbos (potatoes over 3½ inches thick) have been found to give as good a yield and quality of sirup as potatoes of market size. Sound sweet potatoes taken from lots badly infected with soft rot contain flavor absorbed from the decaying tissue. Especially is this true of sound portions of partly decayed roots. Such material is less desirable

for sirup-making than stock never associated with such decay, as the off-flavor remains in the sirup and is difficult to eliminate completely.

Selection of the Malt

Pale distillers' malt of high diastatic power and possessing little or no distinctive malt flavor should be used. It should have been so made that all of the dark-colored, highly-flavored extractives have been removed from the hulls, as well as any bitter flavors from the sprouts.

Preparing the Potatoes for Mashing

Dirt, deep bruises and any decayed tissues other than superficial infections should be removed by washing and hand-trimming. The potatoes are then blanched



Fig. 1 Laying-up sweet potato mash for pressing

Fig. 2 Separating the wort from sweet potato mash by pressing

(par-boiled) either in boiling water or in steam. The purpose of blanching is to remove the extractives which exist in sweet potato peel and which if not eliminated will impart green or brown color to the sirup and disagreeable flavors and after-tastes. Blanching is preferable to peeling as it involves much less labor and waste.

In blanching in boiling water, the potatoes should be surrounded with very hot water in a suitable vessel and the water quickly heated to boiling. After a few minutes the water is drained off, replaced by a fresh supply, and the treatment repeated once or twice.

Experiments in Blanching

In an experiment made to determine the loss in sweet potato solids caused by blanching in boiling water, 12.24 kilograms of Southern Queen sweet potatoes were covered with hot water in a steam-jacketed copper kettle, the water heated to boiling, and boiled for a few minutes. It was then drained out at the bottom of the kettle. A second and third extraction was made in the same way. Finally, the potatoes were cooked for an hour and a quarter in a fourth portion of water. The quantity of sweet potato solids removed by the first extraction was determined by evaporating an ali-

* *J. ur. Biol. Chem.* (1920), Vol. 44, 19

quot portion of the extract to about one-tenth its weight and determining the percentage of solids by use of a Brix spindle.

The percentage of solids, calculated on the basis of the weight of sweet potatoes removed by the first extraction, was 0.17; by the second extraction, 0.16; and by the third extraction, 0.12. The total percentage of solids removed by three 3-minute extractions with boiling water was 0.45. The water in which the potatoes were boiled contained 2.14 per cent. of solids, based on the weight of the sweet potatoes. The three extracts when evaporated were dark brownish-green and had an unpleasant taste. The fourth extract was pale olive-green, and contained no noticeable off-flavor.

In an experiment in blanching in steam, 20,70 kilograms of washed and trimmed Big Stem Jersey potatoes were steamed in the 25-gallon copper kettle which for this purpose was fitted with a steam pipe which passed through a slot in the cover and reached nearly to the bottom. The condensed water drained off as it formed through the valve at the bottom. Portions collected during different intervals were evaporated to a thin sirup, and their weight and solids content determined.

The quantities of sweet potato solids removed, based on the weight of sweet potatoes, taken during the steaming, were as follows: First five minutes, 0.026 per cent.; next 20 minutes, 0.030 per cent.; next 30 minutes, 0.093 per cent.; next 25 minutes, 0.18 per cent. That is, the total loss of sweet potato solids during 80 minutes was 0.33 per cent. The extract collected during the first five minutes when evaporated to thin sirup, was very turbid, dark greenish-brown in color, and had an astringent, disagreeable taste. The second extract was also very objectionable. The third extract was nearly free from very bad color or flavor. The fourth extract, when partly evaporated, became very viscous from the presence of cooked starch. It was nearly or quite free from objectionable color or flavor.

From these experiments it is clear that it is easily possible to eliminate the undesirable colors and flavors in the peeling of sweet potatoes by blanching in water or steam without causing much loss in solids. By evaporating samples of the blanching water and noting color and flavor, the operator readily can determine the nature of the extracts being removed, and use the facts as a guide in controlling the blanching.

If blanched in water, the sweet potatoes are cooked until thoroughly soft in boiling water or in steam. If cooked entirely in steam, the water condensed should be rejected during at least the first half hour of the cooking period. In all cases, at least one hour should be allowed for cooking in order that the cells of the sweet potato may become sufficiently broken down to permit the diastase of the malt to penetrate and digest the starch. The use of steam under pressure is neither necessary nor desirable, as the higher temperature does not hasten the cooking of the sweet potato materially, and there is danger of damage to the stock from scorching, due to overheating.

As soon as cooked, the potatoes should be worked up into a paste. This is best accomplished by stirring, adding sufficient water during stirring to form a smooth thin pulp. The water should be so added as to facilitate the stirring but not in such amounts that the pulp becomes so thin that there is little or no attrition when stirred. About two parts of water to one of potatoes should be used in all. The temperature of the mix is then brought to 140° F., when it is ready for the malt.

Mashing—Determination of Progress by Iodine Test

One per cent. of ground malt, based on the original weight of potatoes, is added and thoroughly stirred into the pulp and the mixture, now technically termed the "mash," allowed to stand with occasional stirring. The temperature should be kept at about 140° F. Considerable divergence, however, is allowable as the temperature may vary between 129° F. and 145° F. without serious detriment.

If the malt is of good quality its action is sure and unfailing and control by use of the iodine reaction is unnecessary. The really wonderful phenomenon of the hydrolysis of starch by diastase, however, can be easily followed by the iodine test; for the sake of completeness, it is perhaps worth while describing it here.

To make the test a small glass funnel is fitted with filter paper and a little of the pulp placed on the filter. When the filtrate runs clear, the drops are allowed to fall into a test tube containing a dilute, pale yellow, cold solution of iodine in potassium iodide. If the test is made before or immediately after the malt has been added, each drop as it enters the solutions forms a deep blue color. As the reaction with malt progresses, subsequent tests give purple, brown, and yellow-brown colors, and finally no color at all.

The action of the diastase is considered complete when no color is formed, and this marks the end of the mashing period. This will occur in from 20 minutes to 1 hour from the time of adding the malt. The range of temperature is below that at which raw starch is gelatinized and dissolved and, as much raw starch is present in the malt, the temperature of the mash must be raised somewhat in order to digest it. Accordingly, the mash is next heated, with constant stirring, to about 70° C. (148° F.). The mashing is now finished, and the mash is ready for separation into wort and insoluble solids.

Pressing

The mash drains so readily that several methods of separation are practicable. The simplest and certainly one of the best methods is the rack-and-cloth system, widely used in the preparation of fruit juices. Here the pulp is laid up in the form of flat cakes between wooden racks, allowed to drain, and finally pressed. The laboratory equipment required for this consists of a screw press, a large pan of sheet tin, forming the floor of the press platform, a set of wooden racks, a wooden form for laying up the pulp, and press cloths of burlap or duck.

In building up what is termed a "cheese," a rack is first laid on the drainage platform. The form is placed on this, and a cloth placed diagonally across the form, the corners being opposite the sides. The mash is poured into the depression thus made. The four corners of the cloth are then folded over so as to enclose the mash completely, the form lifted and another rack placed on top. The form is now replaced and another cake of mash laid up, these operations being repeated until the pile is as high as desired. During the forming of the cheese, a large proportion of wort flows off without the application of pressure other than that due to its weight. A large flow of wort results from the application of light pressure. Heavy pressure finally is used.

The Wort

The wort is subject to rapid deterioration if micro-organisms are allowed to multiply in the racks, cloths,

pressure platform, or elsewhere in the pressing equipment. It is especially difficult to remove all of the sugars of the wort from the wooden racks, and they will mold or sour after use unless promptly and completely dried, or kept under water when not in use. Once in bad condition, they give off noxious flavors to the hot wort and require drastic treatment, consisting of treating with steam for several hours, to put them in condition.

If low pressure only has been used, the washing of the press cake by stirring up with water and repressing will result in the recovery of appreciable quantities of sirup which would otherwise be lost. The washings so obtained may be used instead of water in adding to a fresh lot of pulped potatoes. The yield of first-pressing, dried press cake is about five per cent. of the weight of potatoes taken.

Refining

The sirup prepared as described is well suited for table and culinary use, for candy making and as a mixing sirup. Its appearance can be improved greatly by filtering, as getting it perfectly clear brings out the beautiful natural color. To do this, the only practical method now known is to allow the sirup to stand for at least a day after cooling, in order to allow sufficient time for certain insoluble salts to form. Then mix it with a small proportion (about 3 per cent. of the weight of the sirup) of kieselguhr and enough cold water to insure a reasonably easy filtration. The mixture should be filtered cold as heating it will cause more or less of the salts which have separated out to dissolve and reappear in the finished sirup. A plate-and-frame filter press or pressure filter of the leaf type should be used. The clear filtrate is boiled down to the desired density.

Sweet Potato Sirup

When the raw materials are of good quality and all extraneous flavors have been excluded the sirup is almost flavorless, possessing a faint distinctive taste. When, however, these conditions are not perfectly realized, and this is not always possible in practice, the sirup will contain off-flavors (usually after-tastes) which make it somewhat less palatable. Fortunately, a simple method exists whereby it can be freed from a large proportion or all of the off-flavors which it may contain. This method consists in adding to the sirup somewhat diluted with water about 3 per cent. of its weight of powdered bone char or other decolorizing carbon, heating to boiling, letting stand for a few minutes, removing the char by filtration and then evaporating the sirup to the required density.

Production Costs

From the foregoing description of preparation of sirup from sweet potatoes it is clear that the cost of manufacture is not likely to be high. For the purpose of obtaining additional data relative to production costs and market value to the product, a small production unit is now being installed at Fitzgerald, Ga., in cooperation with the Office of Development Work of the Bureau of Chemistry, of which David J. Price is the Engineer in Charge. Results of importance so far as the practicability of sirup making from sweet potatoes is concerned may be expected.

Summary

The process for the preparation of sirup from sweet potatoes consists first of washing and trimming the potatoes, blanching, cooking, adding water and reduc-

ing to a pulp. The stock is then mashed with malt, pressed, and wort boiled down into sirup. The crude cold sirup is refined by diluting with cold water, filtering with the aid of kieselguhr, treating with decolorizing carbon, and again evaporating. The yield of sirup is about one-third of the weight of the sweet potatoes.

In closing, I wish to thank Dr. C. L. Alsberg, Chief of the Bureau of Chemistry, for his continued support and interest in this work without which the progress described would have been impossible.

Oil Cloth Industry

The Standard Textile Products Co., 320 Broadway, New York, an Ohio corporation, was organized in 1914 to take over the properties of the Standard Oil Cloth Co. of New Jersey, which, with its predecessor company, The Standard Table Oil Cloth Co., formed in 1901, combined seven of the largest oil cloth companies in the United States.

The Standard Textile Products Co. owns and operates five manufacturing plants, located at Montrose, N. Y., Athenia, N. J., Rock Island, Ill., Youngstown, Ohio and Akron, Ohio, also three cotton mills (Meritas Mills) at Columbia Ga., and owns the entire capital stock of the Mobile Cotton Mills, an Alabama corporation having plants at Mobile, Ala., McComb, Miss., and Selma, N. C., and operates the same. Its products consist of the well-known Meritas oil cloth, Meritas leather cloths and Sanitas wall coverings.

The entire product of the Meritas and Mobile Cotton Mills plants is used by The Standard Textile Products Company. The company is the largest producer of lightweight oil cloths in the world. It produces and distributes over 2,000 different styles of product and caters to 60 different industries.

American Glue Co.

In the promotion of the sale of \$1,500,000 of 10-year 8% coupon notes of the American Glue Co., Jesse P. Lyman, president, says: Our company, the outgrowth of a business established in 1808, was incorporated in 1906 and produces and sells glues, gelatines, abrasive papers and cloths of all kinds, soap-stock, soaps, cod liver oil, poultry foods, fertilizer materials and many allied products. Our sales, made chiefly to manufacturers and large consumers, have quadrupled in the last ten years.

Principal plants are located at Hallowell, Me., Peabody, Rockport, Stoneham, East Walpole, Everett, Medford, Cambridge and Boston, Mass.; West Hammond, Ill.; Indianapolis, Ind.; Des Moines, Iowa; San Francisco, Cal.; Springdale and Philadelphia, Pa., and garnet mine lands at Indian Lake, N. Y.

The properties cover a total of about 614 acres, and have an aggregate floor space of 41 acres. The real estate, plants and equipment have a depreciated book value as of Dec. 31, 1920, of \$4,622,222, and an estimated replacement value of nearly twice this amount.

During 1920 large sums were spent in improvements and addition, which include an acid plant at Medford, Mass., which was purchased and a new company, the American Acid Co., organized to operate it, the entire capital of which is owned by the American Glue Co.

The Standard Chemical Co., Pittsburgh, Pa., announces its 1920 radium production as 18 grams, which sold for \$2,160,000, which output will be surpassed in 1921.

Platinum

A Survey of Its Uses, Occurrence, Distribution, Production and Control

PURE platinum is required for chemical work of all kinds. It is used in large quantities in the manufacture of sulphuric acid by the "contact process," in nitrogen-fixation plants, and for making chemical utensils—crucibles, dishes, tongs, and triangles. Platinum is used also in the electrical industry, in the jewelry trade, and in dentistry.*

The so-called platinum of the electrical industry is an alloy that contains 15 to 50 per cent. of iridium and is used principally for contacts on telegraph, telephone, magneto, and other apparatus. It is also used as an element in thermocouples for the electric control of heat in furnaces and ovens.

In the jewelry trade there is a large non-essential demand for platinum for setting precious stones and for making ornamental trinkets. Jeweler's platinum contains an average of 10 per cent. of iridium, although alloys used for some work contain as much as 15 per cent. Platinum is used in dentistry for pins in crown work and pins for fastening artificial teeth to plates and as foil for making cavity molds in which to make porcelain fillings.

Substitutes

For certain uses, as in the manufacture of sulphuric acid and the fixation of nitrogen, no comparable substitutes for platinum are known. In the chemical industry nickel, nickel-chrome, gold, palladium-gold, silica, and even porcelain utensils, have to some extent replaced those of platinum.

In the electrical industry platinum is being replaced by tungsten, molybdenum, and nickel-chrome alloys. Silver-palladium alloys are used for contact and spark devices in internal-combustion engines, but for many high-duty electrical contacts no satisfactory substitute for platinum has yet been found. Palladium replaces platinum to a certain extent in dental work and jewelry. Alloys of gold and palladium and of gold, nickel, and zinc are also used instead of platinum in the manufacture of jewelry.

Industrially Related Metals

The other metals of the platinum group, with which platinum occurs in nature and with which it is frequently alloyed, are iridium, palladium, rhodium, osmium and ruthenium. The first three of these metals are of commercial value. Pure iridium is of little commercial use alone. It is used principally as a hardener in platinum-iridium alloys employed in the electrical industry and by jewelers. Palladium is used chiefly in the palladium-gold alloys that are employed in dentistry and to some extent in the jewelry trade and the chemical industry.

Rhodium is used principally in the rhodium-platinum alloys that form one element in thermocouples for the electrical control of heat. Osmium and ruthenium, the remaining members of the platinum group, appear to be of only slight commercial use, though osmium is said to be a possible substitute for iridium to harden platinum alloys. The natural alloy of osmium and iridium, sometimes called osmiridium and also iridosmine, is used for pointing gold pens.

Natural State

Crude platinum as it occurs in placers is ordinarily a silver-white metal that could be confused only with silver or possibly with unoxidized iron or steel. It can be readily distinguished from silver and iron, for they are soluble in dilute nitric acid, whereas crude platinum can be dissolved only in concentrated aqua regia.

The grains of platinum in some placer deposits are coated with a dark film and somewhat resemble the grains of the dark and heavy minerals—chromite, magnetite, and ilmenite—with which they are associated. Crude placer platinum usually occurs in nuggets, scales, and irregular grains, which in placers that lie near the mother rock may be angular. Sperrylite is a platinum arsenide (PtAs_2), a very rare mineral that occurs in minute crystals.

Native platinum is not a pure metal but is predominantly an alloy of platinum with other metals of the platinum group and with varying amounts of iron, copper, or gold. Most Russian crude platinum contains 80 to 83 per cent. of platinum, and Colombian crude platinum contains 80 to 86 per cent. of platinum. Some placer platinum, so called, carries a large proportion of osmiridium. The crude platinum of California and Oregon carries 25 to 45 per cent. of iridium, and nearly pure osmiridium is found in Tasmania.

Technology

Platinum-bearing sands and gravels are washed in the same way as gold-bearing sands and gravels. The greater part of the Russian output has been obtained by hand washing, but during recent years much of the ground has been reworked by dredges, though probably more than 75 per cent. of the Russian output is still produced by hand labor.

In shallow ground the gravel is mined by open cuts; in deeper ground by shafts and drifts. Over 90 per cent. of the platinum produced in Colombia is won by natives, mostly women, who wash the ground in wooden pans. One dredge is now in operation in the Colombian platinum field. Most of the crude platinum obtained in the United States is recovered in gold dredging. Crude placer platinum must be refined in order to produce the commercially pure metal. A small quantity of platinum has been won by the electrolytic refining of copper-nickel matte and gold bullion.

Geologic Occurrence

Practically all the platinum metals come from placers—deposits of gravel and sand in small streams and rivers—in which the metals occur in grains and nuggets. The platinum-bearing placers of the world have been derived from intrusive basic igneous rocks, including pyroxenite, peridotite, and dunite, and platinum has been found in rocks of these types in British Columbia, Spain, and Russia, but not in commercial quantities.

Platinum and palladium appear to be common in copper ores in deposits of all types and have also been observed in gold veins. Platinum has recently been identified in complex lead-zinc ores in Westphalia, Germany. The nickel ores of Sudbury, Canada, in which the platinum occurs as the arsenide sperrylite, are particularly rich in platinum and palladium.

* From "World Atlas of Commercial Geology. Part I: Distribution of Mineral Production." U. S. Geological Survey, 1921.

Geographic Distribution

Platinum is scattered widely throughout the world. The platinum fields of Russia, which up to the time of the World War produced about 95 per cent. of the world's annual output of platinum, lie in the Nizhni Tagilsk, Goroblagodat and Bisersk districts, in the Ural Mountains in European Russia, a few miles north of Ekaterinburg.

Most of the platinum produced in Colombia, which in 1913 ranked second to Russia as a producer of commercial platinum, has come from the headwater streams of San Juan River, which enters the Pacific near Buena Ventura, although some is found in the upper reaches of Atrato River, which enters the Caribbean Sea near the east end of Panama. Both streams are in the Choco district, which lies in the northwest-ern part of Colombia.

Oceania produces a small amount of platinum and osmiridium. The most notable Australian deposits are in Tasmania, where osmiridium is produced in the Savage River field, in the Bald Hills mining district, in the northwestern part of the island. Platinum-bearing beach deposits extend from Beachy Head, New South Wales, northward past Clarence and Richmond rivers into Queensland. Some platinum has also been obtained from an old buried channel in the Fifield district. In Borneo platinum occurs in the gravels of streams rising in the Bobaris Mountains. Platinum is also reported to occur in New Zealand.

Some of the gold placers in southwestern Oregon and northern California carry platinum also. The dredges in the foothills of the Mother Lode country have been the largest producers. The beach placers on the coasts of Oregon and California have also yielded small quantities of platinum. Copper ores rich in platinum are produced at the Rambler mine, in Wyoming. Platinum-bearing gold ores occur at the Boss mine, in southern Nevada, and ores rich in palladium are mined in southeastern Alaska. Platinum has also been won from placers in central and western Alaska.

A small quantity of platinum is produced every year from placers in British Columbia, but most of the Canadian output of platinum and palladium is recovered as a by-product in the electrolytic refining of the matte obtained from the nickel-copper ores of the Sudbury district, in Ontario.

Platinum occurs in peridotite in the Ronda Mountains of southern Spain and in the gravels derived from that rock. It is also reported to occur in the streams of Granada and some of the more northerly provinces. A small amount of platinum is recovered as a by-product from gold dredging on Irrawaddy River, in India. Platiniferous deposits are reported to occur in Westphalia (Germany), in southern Siberia, in Armenia, in the Kongo country, and at several places in Mexico, Ecuador and Peru. Platinum also occurs in some of the streams and in certain of the gold deposits of the Minas Geraes district of Brazil.

In 1913 Russia supplied 93.52 per cent. of the world's output of platinum and Colombia 5.61 per cent. Even before the World War Russia's output had been slowly declining, and the war reduced it greatly, so that in 1918 it was only 25.83 per cent. of the world's output. The Russian platinum fields are now practically idle; the industry is broken up and can not be restored for many years. Moreover, the known reserves of the Russian fields were rapidly becoming exhausted. Duparc, an authority on Russian platinum deposits, recently stated that if the rate of production

before the war were continued the known platinum deposits of Russia would become exhausted in 12 years. Between 1909 and 1918 Colombia made a slow but steady increase from 2.2 per cent. of the world's output to 69.54 per cent. Colombia appears to have large unworked platinum deposits, but little detailed information is available concerning them.

Centers of Consumption and World Movement

The annual consumption of platinum in the world in normal times is about 325,000 ounces, much more than the production, the deficiency being made up by old platinum that comes into the market. During the war the demand for platinum greatly increased and the supply continually diminished. The principal consumers are the United States, England, France, and Germany.

In the United States the normal annual consumption is about 165,000 ounces of platinum, or about half that of the entire world. Russia, the chief source of the world's supply, normally used little platinum, exporting most of it to England, France, and Germany. The larger part of the Russian crude platinum was sold through a French company and was refined principally in England, France, and Germany. Prior to the war about 70 per cent. of the platinum produced in Russia was sold in England and about 25 per cent. was refined in Germany.

Since 1914 practically no platinum has been exported from Russia, and a large part of the little that did get out was shipped to the United States. Before the war England took, besides the large proportion of the Russian output, probably half of the Colombian platinum and most of the Australian and Indian platinum. This was not all refined in England, however, for considerable crude platinum was exported from England to the United States. A return to the pre-war conditions in Russia may involve the more extensive participation of England in the Russian platinum industry. All of the Colombian platinum is now being sent to the United States, and most if not all of it will probably continue to come here.

Political or Commercial Control of Deposits

Russia has political control of about 90 per cent. of the world's resources of platinum. Colombia controls the next largest area of platinum gravels. Canada, in her deposits of nickel ore at Sudbury, Ontario, and the platiniferous placers of British Columbia, probably controls the third largest reserve of platinum. The known deposits under the political control of the United States in Alaska and on the Pacific coast are relatively insignificant. Great Britain controls the platinum of Australia, Tasmania, and India. The output of the Dutch provinces of Borneo and Sumatra is relatively small but may be increased. Spain may perhaps control a small output of platinum, but its output will its output will probably never become very large.

Prior to the war French commercial interests practically dominated the Russian platinum industry, though some Russian companies were more or less independent of the French, and many small miners and peasants paid no allegiance to any particular concern. The most productive platinum-bearing placers in Colombia are controlled by Americans. Late in 1917 a British company was organized to develop the placers on an upper tributary of San Juan River, but unless the present conditions are changed by the Colombian Congress, American financial interests will probably continue to dominate Colombian platinum.

Some of the platinum-bearing placers of British Columbia are controlled by American and some by Canadian capital. The nickel deposits of Ontario, which produce both platinum and palladium, are operated by the Mond Nickel Co. and the International Nickel Co. under regulations prescribed by the Canadian Government.

ESTIMATED WORLD'S PRODUCTION OF PLACER PLATINUM, 1913, 1917, AND 1918.

Country	1913		1917		1918	
	Quantity of world's (trillion ounces)	Per cent. of production	Quantity of world's (trillion ounces)	Per cent. of production	Quantity of world's (trillion ounces)	Per cent. of production
Borneo, India and Sumatra	200	0.08	752	0.60	75	0.16
Canada	50	.02	80	.03	75	0.16
Columbia	15,000	5.61	32,000	28.52	35,000	69.54
New South Wales and Tasmania	1,500	.56	220	.4	1,006	3.19
Russia	250,000	93.55	50,000	44.2	13,000	25.83
United States	483	.18	605	.72	647	1.28
	267,233	100.00	83,067	100.00	50,328	100.00

* Dutch East Indies and India.

Present Position of the United States

The United States has never produced more than a very small percentage of the platinum it requires, and the output may be materially less when the new refineries for the treatment of the nickel ores of the Sudbury district are completed in Canada.

Most of the placers that carry platinum are small. Many of them cannot be worked at a profit even at the present high prices, and few are available for dredging. As the gold-dredging field along the base of the Sierra Nevada in California becomes exhausted the output of platinum in this country will decline unless new deposits richer in platinum than those now known are discovered.

Platinum is being found in new localities in Alaska from year to year, and the supply from this source may increase.

Effect of Demand on Price

The decreasing world production of platinum and the increasing demand for it are reflected in the increase in its price during recent years. In 1906 it was about on a par with gold, selling for \$20 an ounce. In 1910 it was priced at \$33 an ounce, and just before the recent war began it had advanced to \$45 an ounce. At its present price (1920) of \$113 an ounce platinum is valued at more than five times as much as gold.

The Moore Haven Sugar Corp., Moore Haven, Fla., capital \$1,000,000, has acquired the eight raw sugar plants of the Moore Haven Syrup Co., together with 450 acres of adjacent cane plantation, which will be remodeled to provide for a daily grind of 600 tons of cane. The officers of the corporation are: E. C. George, president and general manager, formerly vice-president of the Syrup Co.; E. J. Hughes, vice-president, in charge of operation, formerly of the Steel Realty Development Co., Buffalo, N. Y.; J. C. Gramling, a local attorney, secretary and treasurer; which, with John Morgan, president, McGraw Tire & Rubber Co., Palestine, Ohio, and L. T. Highleyman, president, Fidelity Bank & Trust Co., Miami, Fla., constitute the directorate.

* * *

Frederick Johnston, formerly with Marden, Orth & Hastings Corp., has joined the staff of the Michigan Iron & Chemical Co., Chicago, as director of the chemical sales division.

Compilation of American Dye Patents in Abstract Form

Color Investigation Laboratory, Bureau of Chemistry, Department of Agriculture, Washington, D. C.

Editor, CHEMICAL AGE:

Early in the development of the Color Investigation Laboratory, the need was felt for a compilation of the American patents on dyes. Miss Aida M. Doyle, at that time employed by this laboratory, undertook the task. It was our intention to publish it, but, owing to its size and the lack of funds available for such a publication from the Department of Agriculture, it was found that it is impossible to do so. Consequently, the Bureau of Chemistry has decided to call the attention of those interested in such a work to the fact that the Color Investigation Laboratory has this in its files where it may be consulted at any time. It should be borne in mind, however, that it is not possible for the laboratory to undertake patent searches.

The compilation is in the following form: Each patent was abstracted under seven different headings in order to make the compilation accessible from as many points of inquiry as possible. The abstract was typed on 3 in. by 5 in. cards, of which as many copies were made as was necessary. A separate file was made for each of the seven headings, so that it is completely cross-indexed, and any patent may be found in any one of seven different ways, viz.:

1. Scientific name, when known, or given in the patent;
2. Intermediates used, with a very condensed statement of the method of manufacture;
3. Class of dye, according to Schultz's eighteen chemical classes;
4. Color of dye;
5. Method of use;
6. Fiber or material for which suitable;
7. Name of owner, and, in parenthesis, name of patentee.

In making the first file it was found that the scientific name was so seldom given and was apparently of so little importance that the file was finally arranged in strict numerical order. Besides the above information, the number and date of patent are given, and, in the upper right hand corner, the Schultz number of the dye, when it is possible to locate it, together with the most common trade name, or the trade name given in the patent itself. Any additional information is added as a note at the bottom of the card. The chemical nomenclature and abbreviations used are those sponsored by Chemical Abstracts.

In order to make the explanation more intelligible, a specimen card is herewith reproduced.

No. 546,177
9-10-1895

S. No. 607—"Rheonin A"

1. Product like Phosphine in properties.
2. Tetra methyl diamine.
3. Acridin.
4. Yellow, brownish.
5. Basic mordant.
6. Cotton, leather.
7. Badische (C. L. Muller).

BENZOPHENONE condensed with *m*-PHENYLENE DIAMIN HCl and *m*-PHENYLENE DIAMIN by heating with ZnCl₂ in closed enameled vessel, on oil bath to 195-215°. The *m*-Amino phenyl AURAMIN first formed combines with diamine to form the new dye.

It is to be seen that the abstracts, and the whole compilation, in fact, are not intended to do away with the consulting of the patents themselves, but merely to serve as a cross-index to them. At the same time, the cards contain enough information to enable the user to decide which of several possible patents is the one he is looking for, without the necessity of handling the patents themselves, thus cutting down on their wear and tear, as well as saving his time.

The compilation has been brought up to date of January 1, 1921, by Mr. Max Phillips and Dr. L. D. Smith of this laboratory, and will be kept as complete as possible. Any one desiring to make use of this compilation should either visit or address the Color Investigation Laboratory.

Joseph A. Ambler,
Acting Chemist-in-Charge.

Obligation of the Technical College to Industry

By Robertson Matthews

Assistant Professor, Sibley College, Cornell University

THE duty to our industries of our technical colleges is a matter in which there is doubtful agreement. This is not surprising. From the bottom social stratum upward the word "duty" is strikingly uncommon in our vocabulary these days. If, however, the duty of our technical professional schools is to advance research, then the industries are, for various reasons, forestalling us in our duty to them. If our duty be to provide the industries with young men having special training, then, here, too, the industries are turning increasingly to helping themselves.

It would appear self-evident that the fundamental duty of our technical colleges is to do for the industries what they cannot well do for themselves. This would suggest that the colleges emphasize, as they do now, the education and some form of training of young men. But what sort of training should be emphasized? There's the rub. There disagreement begins. Let us attempt to answer this by analyzing what our technical colleges are able to do regarding their product. Three primary influences determine what sort of education and training a technical college is able to give a young man, viz., (1) the personal interest of employers, (2) the attitude of the student, and (3) the vision of the college faculty.

To these we might add a fourth, the degree of statesmanship possessed by our politicians. But of this influence we, and we in this article speak for no institution, have little to say. At present a number of thoughtful people are well pleased to have the state do for education no more than it is doing. They believe that when we come to have men in politics possessing the learning and in sympathy with learning and its traditions as are the best minds of Europe, then and only then will they be willing to have the state take the lead in educational inspiration. That great benefit could accrue from the existence of some powerfully stimulating agency above the control of college president, trustee domination and faculty cliques, we do not deny. But America has not arrived there yet, it is feared.

Personal Interest of Employers

The personal interest of employers is a belated influence. For the most part this interest in the colleges is a good deal like the interest of ordinary household consumers in the common-place output of factories. Their experience with the product and the kick that results, come *after* the article is on the market.

The output of the college is no mean commodity. The interest of employers in the college is no com-



ROBERTSON MATTHEWS
Assistant Professor, Sibley College,
Cornell University

mon-place relationship. It is a gravely vital relationship. Social harmony lies behind it. The employers are, however, too busy making money to think it worth their while to take a few days off to visit a college. It doesn't seem to occur to them that it is worth while to inspect the product of our colleges while that product is in process of formation.

It does not seem to occur to them as worth while to give the boys a chance to meet them; or to get from the employer something of the business attitude and the atmosphere of the industrial plant. If this were done on the scale on which it ought to be done there would be fewer men making up their minds just before graduation that they had been taking the wrong course. Besides, some embarrassment would be saved to both the employer and the college graduates.

As things now are the employer, possibly correctly enough, hasn't much faith in raw college men. Hence when he wishes to add one or two young technical men to the plant he takes on as many as he can find room for, and then begins a process of elimination. The selection of human material is a two-sided undertaking. Though sometimes overlooked, we occasionally hear of such a thing as human reactions. The reactions of the green man depend on conditions, and are apt to be affected somewhat by the fact that the interest of the employer in what the student learns about shop life during what, at the time of his graduation, is commonly 20 per cent. of his life, has not been largely in evidence.

Because of the abrupt awakening to what shop life really is and because the men under whose charge they are placed put more emphasis on output than on human reactions, there is a great chance that a lot of graduates soon become disappointed with their positions, with a consequent weakening of purpose and resolve. Those of us of mature years realize that our successes in life, be they large or small, were due in no small measure to the good influence of or the opportunity afforded by some one in control. It is worth considering that one of the best military leaders that any European brigade ever had, went into his first battle as a mere boy with his kindly old colonel leading him by the arm. When it comes to damning the graduate let us split it fifty-fifty with the men in control in the shops. The college graduate is not exactly what we would like to see him, but, let us add, that half the men in control in the shops aren't where they belong.

An excellent thing for a technical college to have would be a house or lodge where graduates long in business would come and relax for a day or two, or longer. Here they could place themselves at the dis-

posal of upper classmen for interviews, and during the day could slip over to the college and spend an hour or two, made available for them, talking to all the classes. It might be objected by some that, partly because the teacher is a strong individualist, there might arise disputes and feeling between some members of the staff and these business men. To begin with, we believe that possibly even an odd cuss word now and then might not endanger the progress of a technical institution. And in the end, to quote Carlyle, nothing is likely to be destroyed but what deserves to be destroyed.

Attitude of the Student

The attitude of the student toward what the technical college may give him plays a larger part in the functioning of the college than is discernible from the outside, and strikes deeper into the character of the work done than most of us care to admit. What is here meant by "attitude" is somewhat inclusive. It does not mean necessarily a desire for high marks. It does not mean necessarily the assiduity of the greasy grind or the much lauded abnormal precocity of the unusual animal. It means a combination of a liking for the work in hand, a willingness to attempt the difficult, and a judicious blending of a desire to arrive at a logical conclusion with a sense of when good enough is good enough.

Some readers will contend that these conditions, in part at least, are those which the college itself should create and foster. A college student should, we believe, be of such material that these conditions will have been brought to the surface before he has entered college. With this inclusive conception of the word "attitude" we believe that our present entrance requirements, entrance examinations and psychology tests do not serve the purpose in our selection of student material for our technical colleges. Such specifications and tests do not sufficiently project into the field of our observation the *attitude* of the applicant toward the privileges of our technical colleges.

Proceeding with the consideration of the influence of the attitude of the student, in recent years there is noticeable a growing desire among engineering students to enter what broadly may be called the business rather than the technical field. These men resent being held rigorously to high standards of scholarship in purely technical subjects. Many times their point of view has merit.

To segregate these men entirely in special courses is, however, far from possible, and when not segregated it would demoralize scholarship if their point of view were tolerated. But not to tolerate their contention is oftentimes the cause of friction from which the other men indirectly suffer. Segregation when too widely attempted is liable to lead to some of the courses becoming pretty thin, while judicious segregation can strengthen the hand of the professor in charge.

The attitude of the student towards marks or grades affects the type of man turned out from our colleges. The too prevalent tendency of young men, men old enough to be officers in the army, to put great weight on marks, must surely be a residual mental condition of their high school years. But so long as such youths are trained for college by women teachers we have little hope for a change respecting the reverence for "marks." We do not blame the women teachers. We blame society for putting on these women a load for which, with few exceptions, they are not adapted. We are often asked (out of school) if we regard marks as

a fitting criterion for graduation. We demur. For the uses of our present world we have our doubts whether the honor man of our American college is our most valuable graduate. Since the influence of the entire college staff is narrowed by the eternal strivings to boost "marks," the type of graduate is affected unfavorably.

The tendency of students to crowd into new courses, may be included in our consideration of the influence of the attitude of the students. Respecting the results of this upon production, such crowding upsets the pre-arranged balance in the division of the men among teachers, and the result, as a rule, is good for no one. When we consider that this rush shows a leaning to the novel and untried rather than to the fundamental and tried, we see the need of a steadying influence.

Here again the influence of engineers, chemists and business men, all of us, upon student opinion, could be most healthy. We are given to doubting the wisdom of the student in his positive faith as to what his life's work will be. There ought to be some additional advice or influence in the selection of courses *after* the student has entered college other than that of the professors.

Most of these men are too close to their own work to get a comprehensive view of the variety of the student's intellectual possibilities; of the youth's tastes; temperament; early training; health, and physical reactions to certain kinds of work; his powers of application and continuity; the commercial developments in the line to which the boy inclines; and—the desires of his parents. These desires oftentimes have more than pathetic possibilities.

We have to face squarely the effects of the attitude of the student upon the teaching staff itself. With such large numbers as our colleges are handling to-day there is a not inconsiderable body of young men for whose good will (we can hardly call it esteem) an instructor may, for personal reasons, gratification of popularity and its possible commercial value, deem it worth while to cater by yielding to their sentiments and standards. Some people deem it conceivable that this catering may occur among those above the rank of instructor. It may be that these cheerful pessimists do see straight occasionally.

Granting they do, the slant view which men trained under such auspices must bring to the solution of industrial disputes, will not increase the confidence of workmen in their employers, or relieve the anxieties of employers concerning the reasoning of their employees. In view of such possibilities among the staff it is safe to say that in paying for their services, it should be borne in mind that something more is being paid for than sheer service. Character deserves recompense.

Vision of the College Faculty

We come now to the greatest of all the influences that determine what a technical college may do for a young man, viz., the influence of the vision of the college faculty. At once we may set up for serious qualification the demi-god of pure intellect and its handiwork, clever policies. Let us be frank. Intellect as worshipped in colleges is not what is running the world. With this admission we are not arrived where we can state the duty to industry of our technical colleges? We conceive that duty to be this, viz., *to provide the industries with men capable of handling men.*

Let us right here make a sharp distinction between what we would have as the purpose of a technical col-

lege and the purpose of a trade school. Let us leave trade schools to turn out artisans. The technical college should yield first place only to the home in being something different from the shop and factory. While preserving measure in all things, principles must take precedence over production, and efficiency must yield first place to the cultivation of respect for truths, both ethical and scientific.

Truth is the foundation of science and progress. It is the spread of half-truths that is disturbing industry at the present time. Looking into the nature of the turmoil about us to-day we challenge any worshipper of commercial efficiency to give us a definition and interpretation of efficiency, as he is advocating it, that will keep alive in the masses of to-day a desire to work.

Further, we have overworked the belief that traditions restrict progress; that the world began when we were born. There are those who believe, and with some justice, we fear, that our present-day commercial armies will pass away as did the military armies of Rome. Our slag heaps may possibly be regarded some day as the pyramids of the commercial age.

But just as the greatest heritage that Rome has left us is Roman law, just so the greatest heritage that we shall leave will be our scientific laws. It is doubtful, however, whether we have as yet any scientific laws of human living that shall survive. Our increase in physical comforts does not furnish proof that we are increasing among the masses of humanity a reconciliation to accept life as it is being fanded to them.

What destroyed Rome was that which she considered her greatest occupation, war. Our greatest occupation to-day consists in de-humanizing industries. In these industries many are forgetful that man first and last is an unusual animal; that he has come down to this age by following the dictates of natural laws and tastes. Deprive him of the expression of his age-old inherited tastes and—well, Nature does not know what 100 per cent. efficiency means but she usually has her way. It looks as though we shall somehow have to develop more men who can give the human touch to the organization of industry.

Cultivate Humanity

We believe that the vision of the faculty of the technical college should provide for the development of that human touch. Their product should be not automatons. Not intellectual slide-rules but potential leaders of men—our present gravest need. The proximity of a technical college, as a unit in a university, to the college of Arts and of Law, points to the folly of our letting our technical colleges be but trade schools. These other colleges should, by influencing the engineering and chemical student, aid in giving industry its greatest need, the human touch.

Leadership

We are aware, of course, that the capacity for leadership is one of the things which the college man may acquire when he enters the industrial plant and there begins his post-graduate course. But we take exception to over-emphasizing this possibility. Nor are we sure, under remote leadership and doubtful opportunity, of his there developing the human touch.

We believe that a capacity for leadership—with the human touch—can be well begun in our colleges. We know it *has* been done on a small scale.

For those who would set aside such an attempt in order to concentrate upon the imparting of knowledge and the development of more or less (it usually works

out to be less) facility and accuracy in engineering calculations, we beg to say that they are not rising to the realization of the possibilities of the technical college. Let us have scholarship to be sure. But scholarship obtained by a machining process such as our institutions are committed to today in their attempts at mass production is a skimmed-milk cheese.

We would have it understood that we are not decrying universal education. And we are willing to admit that a machining process is possible upon any horde that you can crowd through college doors. But we feel that to accept such efforts as college education or as meeting the needs of industry, is to reveal either a lack of vision or else wilful evasion of responsibility. To be obsessed over quantity at the expense of a much needed quality is to be remiss in our duty.

In attempting mass production in our colleges we are attempting it in a field of endeavor where mass production does not apply. Mass production means standardization. Standardization kills initiative and originality, fundamental characteristics of a leader. Standardization as surely follows in college work when numbers increase as does the formation of a puddle under a leak in a roof. An unwise provision brings both about, and the forms of life therein developed are about on a par when it comes to getting somewhere.

Character

We may, to be sure, when mass production is introduced into our colleges, turn out a few characters which when compared with the mass seem pretty fair material. But is the mass to be our criterion? We are inclined to believe it already is. Consequently with such a small margin of difference between our best product and the entire output, we are not surprised, if under but slight exactions, our product falls down. A capacity for leadership includes what we commonly see heading the list of the desirable characteristics in an employe and assistant, viz., character. Character does not thrive well under mass production.

Mass production in our colleges tends to narrow the influence and results of their staffs by the strict limitations placed upon the ground to be covered and the procedure. Marks and grades tend to become the important gages by which the crowd of students can be expeditiously judged as fit material for degrees. A mark becomes the all and end all of college endeavor. The exalting of high standards of scholarship may be desirable, but another result is what all the world conceives as typical of a college professor, a one-track mind. Whether a young man by scholastic contact with a number of one-track minds can develop a three-, a four-, or a five-track mind, is a dubious consideration. We do not believe that mass production is conducive to vision in a college faculty. We cannot, therefore, believe that mass production can give us college graduates with the capacity for leadership, with the human touch begun in them.

So much for analytical criticism of those influences which, as we see them, determine whether the technical college can perform what we conceive to be its present duty to Industry. What constructive criticism would we present? What provisions can we suggest in an effort to increase the capacity for leadership in our college graduate?

We present the following items for consideration:

- I. Elimination of the obsession that numbers are indicative of the greatness and worth of a technical college.

II. Keeping in mind that for training youths no methods of organization can take the place of personal contact.

III. Effective teachers are not made but born, and that the supply is not sufficient for wholesale education. Further, that the capacity to paddle men over a course doesn't constitute teaching.

IV. Mass production in education is not feasible for obtaining the type of men we need, and our attempts at it may prove a national blunder.

V. That to give at once a heavy technical course, a humanizing course, and contact and experience to originate capacity for leadership—is too much to be attempted in four years with the average man now entering college. We must, therefore, revise the technical portion of our aims or else make a different selection of men.

VI. Considering that the clean athlete with scholarship between seventy and eighty, is probably our most useful man to-day, it might be well in our future graduation of men to insist upon moderate athletic prowess.

VII. A broadening of our attitude and aid towards athletics. There is probably no college experience that lends itself so effectively to a student getting "the hu-

man touch" that makes for leadership as does clean athletics under good coaches.

VIII. In order to obtain the type of graduate we desire we must be willing to pay the price to put small numbers of youths under men who themselves are, as nearly as we can obtain them, both born leaders and teachers.

IX. In our attempt to supply industry more generally with a higher type of graduate we must, while restricting if necessary our output, develop by all means in our power men free from class consciousness. One method of restricting our effort to the type of men we desire would be possible if we had some form of universal apprenticeship. A college education, together with reduction in time to be spent in the industrial plant, could be given as a reward to those who manifested in the shops those several characteristics desirable in those who are to direct and lead in industry.

When in our technical colleges we shall find a live, warm, continuously flowing interest coming from employers, an all around hungry attitude in the students, and a wide angle vision in the faculty, then will our technical colleges be performing their duty to Industry. They will be providing Industry with leaders—with the human touch.

New Borax Deposit—Production in 1920

THE largest known deposit of borax has been discovered in Clark County, Nevada, its genuineness having been confirmed by Hoyt S. Gale, of U. S. Geological Survey. The deposit has been purchased outright by the West End Chemical Co., Searles Lake, Cal., of which F. M. (Borax) Smith is founder and president.

The deposit comprises a hill of pure colemanite, a calcium borate, some 3,000 feet in length and 300-500 feet in height; it is estimated that more than a half-million tons of the ore are in sight. The location is only 18½ miles from the main line of the Salt Lake Railroad in Clark County, 46½ miles by automobile via a roundabout route from Las Vegas, and about 7 miles from the Colorado River. Though easily accessible, it is in a wild region, locally termed the "Muddy Mountain Country," of which hitherto little has been known.

Six months ago, two prospectors decided to make a thorough exploration of this region. These two men, George D. Hartman and Francis Marion Lovell, were "grub staked," the former by a woman in Salt Lake, and the latter by Peter Buol of Las Vegas. After months of fruitless search in which they worked their way toward the Colorado River, the explorers came to the mouth of a narrow canyon that looked like scores of other canyons they had investigated. Hartman, entering it a short distance, saw nothing of interest and suggested looking elsewhere. Lovell, however, had a "hunch," and going farther into the canyon, called back, "I think I see indications of colemanite here."

Very soon the explorers came upon out-croppings of whitish ore resembling quartz, measuring across the exposed faces 10 to 20 feet and in one place 46 feet or more. They continued their observations until they had made an approximate estimate and were convinced they had discovered the largest known deposit of colemanite. The date of discovery was January 23, 1921, and the honor of discovery was credited by Hartman to Lovell. The discoverers offered their property to F. M. (Borax) Smith, who, after a brief investigation, was assured

that the deposit of colemanite was all that had been represented. Mr. Smith's acquirement of the property is said to be one of the biggest mineral transactions of the kind ever made.

Colemanite was discovered in Death Valley in 1881 by F. M. Smith, now 72 years of age, and his associate at that time, W. T. Coleman. The latter proposed to call the ore "Smithite," but Smith successfully contended that Colemanite, being more euphonious, should be the name.

When Smith first discovered borax at Teels' Marsh, Nevada, forty-nine years ago, borax was little known and little used. It now has developed into great industrial importance. It is the intention of the West End Chemical Co. to begin shipments of colemanite as soon as possible from Dyke, Nevada, on the Salt Lake Railroad until a spur line is built to the property. The proximity of the deposit to the main line of the railroad and the ease with which it can be mined will enable the company to meet competition any place in the world.

Borax Production in 1920

Production and sale of borax in 1920, 35,280, valued at \$5,674,000, surpass that of any previous year; in 1919, 28,518 tons, valued at \$4,351,891 were produced. The total quantity of crude borates produced in 1920 amounted to 120,230 tons, valued at \$2,173,000. This is a record in quantity though not in value, on account of the lower grade of the ores.

The Zeller Lacquer Manufacturing Co., Inc., has purchased the plant of Goodin-Reid & Co., at Irvington, N. J. The plant consists of five one-story buildings, having a floor space of approximately 35,000 square feet, on four acres of land, with Lehigh Valley Railroad siding. The new owners expect to begin operations about June 1.

* * *

The American Vat Color Co., Chicago, Ill., has enlarged its manufacturing facilities by the acquirement of an additional building.

Personal Items

Thomas Robertson, of the patent law firm of Robertson & Johnson, Washington, has been appointed commissioner of patents.

* * *

Arthur L. Day announces a change of address from Corning Glass Works, Corning, New York, to Geophysical Laboratory, Washington, D. C.

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H. E. LaBour, formerly of the Central Equipment Co., of Chicago, will establish a consulting and sales office in that city.

* * *

W. R. Holt, formerly with the Procter & Gamble Co., is now plant superintendent of the Harris Soap Co., Buffalo, N. Y.

* * *

R. L. Sibley, formerly research chemist with the Goodyear Tire & Rubber Co., Akron, Ohio, is now in the development department of the Standard Oil Co., of New Jersey.

* * *

Gustave MacDonald, formerly chemical engineer with the Bayer Co., Leverkusen, Germany, is now with the E. S. du Pont de Nemours & Co., Wilmington, Del.

* * *

Edward Mallinckrodt, president of the Mallinckrodt Chemical Works, St. Louis, Mo., has the distinction of being the largest individual taxpayer in that city.

* * *

H. M. Miner, 110 William street, New York, has been appointed New York representative of the Cleveland-Cliffs Iron Co., of Cleveland, Ohio, producers of wood alcohol and wood chemicals.

* * *

Dr. L. A. Mikeska has resigned from the Color Laboratory of the Bureau of Chemistry, U. S. Department of Agriculture, to join the staff of the Rockefeller Institute for Medical Research, New York City.

* * *

William J. Kanary, formerly manager of the fertilizer materials department of Charles F. Garrigues & Co., is now at the head of the newly organized Packing House By-Products Co., at 2 Rector street, New York.

* * *

V. V. Carmichael, formerly assistant power superintendent of the Aluminum Ore Co., East St. Louis, Ill., is now in the efficiency department of the Columbia Chemical Division of The Pittsburgh Plate Glass Co., Barberton, Ohio.

* * *

H. J. Haon, formerly manager of the Newburgh plant of the Du Pont Co., has been made manager of the Fabrikoid Promotion Bureau. He is succeeded by Clifford McIntire, with William A. Schnedeker as superintendent.

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W. T. Schaller has resigned as chemist in the Division of Physical and Chemical Research, United States Geological Survey, and has accepted a position with the Great Southern Sulphur Co., Inc., of New Orleans, La., operating at Orla, Texas.

* * *

Howard C. Arnold, formerly chief chemist and plant manager of B. F. Drakenfeld & Co., manufacturers

of ceramic colors, 50 Murray street, New York, has joined the staff of Arthur D. Little, Inc., Cambridge, Mass.

* * *

The newly organized engineering department of Pease Laboratories, Inc., 39 West 38th street, New York, is in charge of Dwight Tenney, formerly chief engineer of the Franklin Baker Co., refiners of cocoanut oil and manufacturers of cocoanut products.

* * *

Robert W. Swift, treasurer, Solvay Process Co., and vice-president, Solvay Collieries Co., has resigned from these positions to accept the position of senior vice-president of Wing & Evans, Inc., sales distributors of Solvay products, 22 Williams street, New York.

* * *

Dr. F. A. M. Noelting, director of the technical laboratory of the Du Pont Co., at Deepwater Point, N. J., has been assigned to export work. Dr. R. E. Rose, of the chemical department, has been transferred to the Dyestuffs Sales Division as assistant director of the technical laboratory.

* * *

Arthur C. Trask has resigned as vice-president of the Marden, Orth & Hastings Co., Inc., and has become vice-president of the Falk Co.; Pittsburgh, Pa. The Falk Co. plans to equip a plant at Carnegie, Pa., for the refining of menhaden fish oil and for the sulphonating and processing of oils. The technical staff of the company will be headed by Dr. Rothberg.

* * *

Dr. Colin G. Fink, of South Yonkers, N. Y., who organized and directed the Research Laboratories of the Chile Exploration Co. for the past four years, has resigned his post. Dr. Fink recently invented a new chemical process for the reduction of tin ores. His insoluble anode is now being introduced at the large copper plant at Chuquicamata, Chile.

* * *

Hervy J. Skinner, formerly vice-president of Arthur D. Little, Inc., and for the past two years a consultant in Boston; Gustavus J. Esselen, also of the Little, Inc., organization, and Herbert L. Sherman, of the New England Bureau of Tests, have incorporated, acquired the good-will and business of the Boston Biochemical Laboratory, and established headquarters at 248 Boylston street, Boston, Mass., as consulting chemists and engineers.

* * *

Much note is made in New York of the movements of Dr. Albert Einstein, of the University of Berlin, and Professor Chaim (Charles) Weizmann, formerly head of the British Admiralty chemical laboratories during the war. The Chemists' Club conspicuously is absent among the local chemical and political literati in extension of formal hospitality to these scientists. Dr. Einstein is notable for his theory of relativity. Prof. Weizmann is familiar to solvent chemists for his patented processes now worked commercially in this country for the production of alcohol homologues and acetone by bacteriological agents. He is president of the World Zionist Movement and heads the commission to this country to arouse interest in the establishment of a Jewish nation in Palestine and incidentally in the founding of a Hebrew University in Jerusalem.

Industrial Notes

The Carter White Lead Co., of Canada, Montreal, Quebec, will build an addition and install new machinery.

* * *

Carolina Pine Products Co., capital \$25,000, C. R. Poole, president, will build a plant at Hamlet, N. C., to extract turpentine, tar and oil from pine stumps.

* * *

The Sutton Chemical Co., Sutton, W. Va., will erect a new electric power plant in the vicinity of its recently acquired coal mines in Wolf Creek, Braxton County, W. Va.

* * *

The Citricuba Co., capital \$100,000, has been organized at Anaheim, Calif., to manufacture orange food products, one of which will be orange jam in cube-form.

* * *

Palo Co., laboratory apparatus and supplies, formerly at 90 Maiden lane, is now located at 153-157 West 23d street, New York, where three floors are used for offices, display rooms and storage.

* * *

The Millville Pulp & Pine Products Co., Millville, N. J., will erect a new one- and two-story mill for the manufacture of wood pulp. Considerable machinery will be installed.

* * *

The Insulite Co., Ellensburg, W. Va., has been organized to manufacture hard rubber substitutes, molding novelties and electrical insulators from composition, bakelite, condensite and redmanol molded parts. A factory building 80x160 ft., is now under construction.

* * *

V. J. Boulton, C. H. Boulton and J. Leopold, trading as the Consolidated Instrument Co. of America and featuring speed indicators and other meters, have lately opened sales and executive offices at 461 Eighth Avenue, New York City.

* * *

The Hennepin Atomized Fuel Co., 520 Security Building, Minneapolis, Minn., will erect a one-story fuel-crushing plant, 60x150 ft., at St. Paul, Minn., estimated to cost about \$150,000 with machinery. C. L. Bohannon, chief engineer, is in charge.

* * *

The Welch Grape Juice Co., Westfield, N. D., will establish a \$400,000 plant at Springdale, Ark. One thousand five hundred acres of land have been purchased and it is expected that 6,000 tons of grapes will be available when the plant is opened in 1922.

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The Cooknut Corporation, Baltimore, Md., capital \$250,000, 8 per cent. preferred and \$250,000 common stock, has been organized to manufacture lard substitute. A plant will be erected of present daily capacity of 55,200 lbs. W. R. Spruill is president and J. D. Peake, treasurer.

* * *

The latest enterprise of the Ford Motor Co. in embarking in the production of accessories and raw materials necessarily used in great quantities, is the manufacture of celluloid. Announcement also is made of the enlargement of its paint and artificial leather plants.

* * *

By arrangement with the receivers and creditors of the Midland Packing Co., Sioux City, Ia., Wilson & Co., Inc., packers, will lease the plant for five years at

an annual rental of \$150,000, with an option to purchase after two years and within three years at about \$2,500,000.

* * *

Phanotax Chemical Co., Memphis, Tenn., K. C. Joplin, vice-president, and general manager, will erect at Tulsa, Okla., a seven-story and basement, 300x150 ft., fireproof factory building, costing \$400,000, and will install equipment for the manufacture of chemicals and dental and toilet specialties.

* * *

Twenty-eight million pounds of smokeless powder have been sold by the War Department to the Bethlehem Chemical Co., recently incorporated with a capital of \$3,500,000. The price to be paid is one-half cent per pound, "as is, where is." The United States is to receive 60 per cent. of the net amount received by the purchaser in the event that any of this material is re-sold for use as smokeless powder.

* * *

The new strawboard plant to be built by the H. K. Ferguson Co., Cleveland, for the Hinde & Dauch Co., Sandusky, Ohio, at Fort Madison, Iowa, will include a rotary building, 45x130 ft., two stories; a beater building, 65x110 ft., four stories; a two-story machine building, 40x300 ft.; one-story storage building, 120x220 ft., and a two-story power plant, 75x120 ft. All the structures will be of reinforced concrete, brick and steel.

* * *

Dr. S. S. Wyer, of the Bureau of Mines, at a conference of gas producers and distributors called by the Corporation Commission of the state of Oklahoma, at Oklahoma City, declared that the annual waste of natural gas in that state from defective distribution equipment amounts to \$275,000,000, which waste, if not prevented, can lead only to the financial embarrassment of the natural gas companies. In Dr. Wyer's opinion Oklahoma's natural gas, if properly conserved, should last twenty-five years.

* * *

The American Leather Research Laboratory which has been maintained at New York for the past three years under the auspices of the Tanners' Council, has been transferred to the University of Cincinnati, where it will be under the direction of George D. McLaughlin, of the University staff. The laboratory will be a department of the College of Engineering and Commerce and will be known as the Department of Leather Research, Tanners' Council of the United States of America Foundation.

* * *

At the annual meeting of the stockholders of the Eastman Kodak Co., held April 1, at Jersey City, N. J., was approved the recommendation of the board concerning acceptance of the report on the stock distribution among employees, initiated several years ago by Mr. Eastman. He then gave \$1,000,000 of common stock to be distributed among the older employees, the company to give the same amount to be sold among the newer employees. The plan was put into effect in 1919, and the report told of its working out. The company's annual report was not ready, owing to the delay of reports from foreign subsidiaries.

Four directors whose terms expired were re-elected. James S. Havens, vice-president and secretary; Frank S. Noble, vice-president; James S. Watson, and L. B. Jones, advertising manager, all of Rochester.

CHEMICAL AGE

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A Survey of American Electrochemical Development

By Walter S. Landis

Chief Technologist, American Cyanamid Co.

AT long and irregular intervals it was the habit of the proprietor of the cross-roads store to walk slowly through his place of business, glance to the right and to the left, and up and down, and make mental notes on the status of his stocks. So long as this crude method of determining his inventory was satisfactory to himself he remained the country store-keeper or fell by the way-side. If, through accident, he developed to the stage of actually "taking stock," he abandoned the country store, moved to the nearest town and opened up a larger and more elaborate, though frequently more specialized place of business.

There is a wide difference between the primitive stock-taking of the cross-roads merchant and the continuous inventory, carried by our modern corporation, and we of the newer school are still theorizing as to the ways and means which keep some of the old timers in the field. At the same time when we look into our own branch of industrial activity I think we will find its system of inventory is in much the same condition as that of the cross-roads store.*

Are we carrying such a form of inventory as to enable the quick determination of the quantity and quality of stocks on our shelves? Is this stock suited to our markets? Will we be able to meet our competitors on their own terms? How much do we know of the future prospects of our business? Remember, I am speaking here of the industry as a whole and not of any specific branch or unit.

Capital Invested

The industry with which we as members of the American Electrochemical Society are associated—that one utilizing the chemical and thermic effects



WALTER S. LANDIS
Chief Technologist,
American Cyanamid Company

of the electric current—represents, on the North American Continent, an invested capital of something over six hundred million dollars. As a matter of fact this actually may be upwards of a billion dollars, but our antiquated cross-roads system of keeping our inventory does not permit us any great degree of precise determination of such factors. The lesser figure does not include, so far as it has been possible to segregate the same, those portions of plants not exclusively a part of the electrochemical process; nor does it include generating stations where they are operated as separate corporations. The great difficulty, however, has been to determine where the line should be drawn in those industries which use the same equipment for products derived from electrochemical or electrothermic sources, and from other sources independent of the electric current. It is this indefiniteness that represents the difference between the six hundred million dollars and the billion dollars mentioned above.

The casting of a balance sheet of an industrial group the size of ours is a somewhat different task from merely keeping up the inventory of an individual unit making a part of the whole. We are dealing with factors here as fundamental items, which are usually only considered from the unit standpoint as intangibles.

My attempt at compilation will fall far short of the desired completeness we all desire, but matters of this sort and in this place can always be passed on to one's successors.

Location

Our first item of consideration is the value of the location we have chosen to establish our industry. It is not unusual to hear, for example, that Norway is the logical home of the electrochemical industry, or that Germany will stifle all future competition

*Presidential Address, American Electrochemical Society, Atlantic City, April 22, 1921.

in our line. Are we to consider on the basis of such broad and unsupported statements, that our choice of location has been an unfortunate one—that we are located on a side-street in a poor neighborhood—that America is a liability to us instead of an asset. Personally, I have no time for such propaganda—I am not even disturbed by the fact that a prominent American corporation has established a Norwegian branch factory. The mere fact that Norway seems to have an abundance of undeveloped water power will not make it the Mecca of the electrochemist, for it takes more than undeveloped water power to build up an industry such as ours, and when one considers that Norway possesses no local markets, must import every pound of coal and coke, is short of skilled labor and uncertain as to temperament of the little unskilled labor available, I am not ready to write off very much on our choice of location.

In appraising the value of location, one must consider many factors, for example; the liberal form of Government under which we live for a time showed a decided tendency towards an unfortunate socialistic attitude to industry. This now appears to have been only an incident of the War and prospects ahead of us are that we shall soon be clear and free to develop in proper competitive and individualistic manner. Laws governing proper combinations for meeting foreign competition are becoming more constructive and helpful. Outside of England I do not believe a single European nation can today compare in as liberal prospective legislative helpfulness. As to transportation, the War left us a great fleet of merchant ships capable of taking adequate care of our export business. Unfortunately, operation of this fleet is handicapped by marine laws framed by prairie sailors. Some day our scheme of Government may advance to that state of development where political expediency makes way for skill and experience in the proper planning of specialized activities. Improvement of inland navigation in many cases goes hand in hand with hydroelectric development, all of which will help to unload our railroad systems. The electrochemical industries should be the preferred customers of such inland water transportation systems because of their location.

Our railroad system is the best in the world, even in spite of the universal domestic criticism. Just ask any returning foreign traveler. But development is at a standstill, rates are impossible; in fact, in this case "best in the world" means really everything is pretty poor. The railroads are in for a complete reorganization—new management—new policy,—greater efficiency from fewer and better employees—and they had better start pretty soon and get it over with or industry will again be on their heels.

The recent water power legislation will certainly lead to several important new hydroelectric developments and the possible establishment of new electrochemical centers. When prices of construction materials and labor drop to a point when the fixed charges imposed on the power cost are not too burdensome, work will begin on the many long-delayed projects. Our industry is bound to profit through these undertakings.

Raw Materials

Someone has said that electricity in electrochemistry is merely an excuse for burning coal. When one

looks over the fuel requirements of the heavier electrochemical industries, the statement is not a great exaggeration. Nowhere outside of the United States is there already developed the abundance of high grade fuel that we have near our electrochemical centers. Continental fuels are of inferior grade and higher in price. Even English coals are going to be expensive in the future. Of the materials for making electrodes, we have in plenty and of such quality that today our large carbons command first place throughout the world.

It is true that there are a few raw materials used in this industry with which we are not abundantly supplied. During the war emergency special efforts were made to develop the production of these miscellaneous materials and the efforts were crowned with some success. If a fraction of the great sums of money spent on war plants which were of absolutely no use whatever toward the winning of the war,—and I am not including here many plants founded upon perfectly sound engineering judgment and certain of performance but not completed before the signing of the armistice—had been spent on the search and development of some of our less plentiful raw materials, I might have a different story to tell with respect to these less abundant materials.

Personnel

The chemical industry of this country is comparatively new. We do not possess the background of alchemists that Europe had, but we seem to be fast making them. Our schools of chemistry have only in the last few years taken on a semblance of Americanization, for most of our older teachers were educated abroad and equipped their laboratories almost exclusively with foreign apparatus. This has not been altogether satisfactory, for our industry is primarily an American one using American processes, worked in American apparatus; and supervised by American engineers. Aluminum, carbide, graphite, metallic sodium and a host of other products are primarily of American origin. The caustic soda and chlorine industries use almost exclusively American cells.

As a matter of fact, I do not know of anything in the industry of any great importance that has been brought over from Europe and held to its original European form for any length of time, and I know of only one considerable development in Europe that seems not to have been brought here at all. With these facts in mind we must agree that the American engineer is superior to the European in all electrochemical and electrochemic development, in spite of his semi-European training. It is our duty to impress these facts upon the direction of our schools of higher education and render all the assistance we can to Americanize their methods and equipment.

Capital Income

Our industry with six hundred million to one billion dollars of capital investment looks for a profit of from one hundred to two hundred million dollars annually to meet capital charges and provide for reasonable growth and development. This return must come from the direct efforts of those charged with the conduct of the business—the executive, superintendents, engineers, chemists, etc. In other words, men largely technically trained are responsible for the earning of this enormous sum of money, and the universities and technical schools must in

turn supply these men. Looking at this from a "gross" standpoint the electrochemical industries must return approximately five hundred million dollars per annum, largely via university products.

Electro-Chemical Education

Only a few technical schools make direct attempts at turning out electrochemists. Some others merely provide auxiliary courses in electrochemistry, and a still larger number merely group the subject with physical chemistry. There are practically no schools capable of properly handling post-graduate students in electrochemistry because they do not have the necessary equipment.

In our schools of civil engineering we give our men regular drafting equipment. They work with standard levels and transits, and do not use small-scale model testing machines in their study of materials. In our schools of mechanical engineering we provide our men with regular boiler plants and operating steam engines, not models. The students are not forced to work with miniature automobiles or internal combustion engines in any laboratories with which I am familiar.

Why, therefore, should we expect in the training of our electrochemists that they should do their work in the laboratory entirely with glass beakers or similar small scale equipment? Why should the only representative electric furnace with which they ever come in contact during undergraduate days be either a picture or a small model, or, in a few particularly fortunate cases, exist in some nearby industrial plant that is open to their general inspection.

If we are going really to educate electrochemists we must provide in the University as a part of the daily working equipment, not models, but actual industrial installations, and operate these before and with the student through the assistance of practical electrochemists, supplementary to the theoretical instruction and lecture work.

I very much doubt if the universities of this country have available and are spending one hundred thousand dollars per year for the direct teaching of electrochemistry. I do not know of a single school laboratory that has a thousand kilowatts available for electric furnace work, or more than a model plating or refining equipment. If the industry is going to expect the graduates of institutions operating under such handicaps to return to it a gross of some five hundred million dollars per year and a net of from one hundred to two hundred million dollars, they will have to do something for our educational institutions along electrochemical lines, otherwise the German threat may not be all propaganda.

American Electro-Chemical Society

Our Society holds two meetings a year, and averages nearly a thousand pages of publication annually. Our system of keeping inventory does not permit us to determine just what net returns the industry obtains from the communications, meetings and other services rendered by it. It is my opinion that it adds directly a good many thousand dollars per year towards the net of the corporations. I am certain that if we include the dues of members paid by the corporations, the corporations will not have contributed twenty-five hundred dollars per year to the support of the Society, an extremely small percentage of the net return they derive from the existence of just such a body as this.

The Society is doing the best it can and to the extent of its available means to advance the inter-

ests of electrochemistry. With larger means it could do a great deal more. The officers of the Society believe that it would be unwise to attempt to raise additional funds by increase of dues. There is, therefore, only one way to obtain the greatly needed additional income which the Society could profitably use, and that is through some working arrangement with industry whereby additional funds could be secured on something other than a charity basis. Since I am merely casting up an inventory which is presumed to be a record of facts and not of opinions I merely wish to leave this idea with my successors with the hope that they can work something out of it.

Labor

As to the ordinary labor in our plants, I am not prepared to say that it is of as high quality as might be found in other countries, but at the same time I will not class it lower. On the other hand, we use only a fraction of the quantity in this country that is used abroad. We use automatic devices much more freely. We build larger units and operate them at higher capacities. In consequence, while our common labor may not be quite so steady, and is not so cheap per man hour, when we consider the quantity used, I do not believe that labor places an extremely serious handicap on the development of the American industry. There are many labor abuses which will have to be corrected. The demoralization incident to the war is already being eliminated and it will probably not be long until our labor cost will not be the determining factor in foreign competition.

Reviewing our item of personnel, I think we can list the engineering ability, inventiveness and efficiency of the American engineer and chemist and the American workman as an asset of particularly high value. I cannot place the technical school and the Society on the other side of the balance sheet, because that would put them in the false light of being liabilities, when as a matter of fact we know they are not, and have been rendering wonderful service under existing handicaps, but at the same time I think we must all admit that they are not up to the standard we are desirous of setting for such institutions and that our first endeavor in rectifying this inventory should be directed to improving the status of these two items.

Conclusions

Close scrutiny of our balance sheet shows our industry to be in excellent condition. Every such report I have ever seen of a going concern always has a liability side and we are no exception. General business conditions at this time are not good. Low exchange values of foreign coins, coupled with questionable economic practices in some of the European countries, are causes of temporary but immediate concern. Bad habits acquired by our legislative bodies during the war and not yet broken will trouble us for sometime. The relationship of our schools and this Society to industry can be improved. All must be weighed and considered.

On the other hand, the wonderful opportunities America affords for the development of our industry, the skill, activity and courage of our engineers, all against the historical background set up by Acheson, Castner, Cowles, Hall and a host of other early workers, can mean only the most successful future. Let us take full advantage of the opportunity.

Improvement in Fatty Acid Distillation

By John W. Bodman

THE necessity of utilizing fat raw materials, not only as a source of commercial fats whereby can be made available additional supplies of industrial fats to replace those portions lost for industrial purposes by their pre-emption for edible uses, but as a contribution to manufacturing efficiency, has given to the art of fatty acid distillation a distinctive place in the fat and oil industries. The recoverable values in the by-products of glyceride oil refining are too great not to warrant diligent effort to liberate them in the highest possible commercial form. Fatty acid distillation particularly is applicable in the soap and stearic acid industries for the production of light-colored fatty acids from refinery "foots," etc., which are too dark-colored for direct use in the soap kettle.

John W. Bodman recently has patented* improvements in process and in combination of equipment whereby is possible a more complete recovery of the essential ingredient of low-grade fatty materials, with considerable elimination of color and odor, in the realization of the fatty acid distiller's ideal of a maximum yield of fatty acids and a minimum production of pitch or residue.

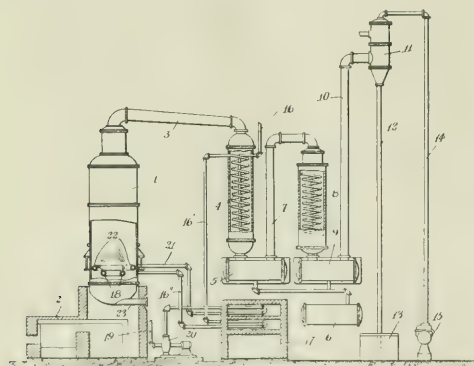


Fig. 1. Diagrammatic Cross-Section of Improved Fatty Acid Still

The invention comprises the use of several improved features which may be used separately, or, for the best effect conjointly. One of these features relates to the introduction of the fatty acid into a still, in the vacuum distillation apparatus, in the form of spray. The sprayed material, which has been preheated, mingles intimately within the still with superheated steam or other gaseous carrier with the result that a thorough and speedy evaporation of the material takes place.

Another feature of the invention consists in the utilization of the latent heat of the evaporated fatty acids to preheat the steam or other gaseous carrier. Thus the vapors from the still may be caused to pass over a coil of pipe through which the gaseous carrier passes on its way to the still, some of the vapors being condensed and the steam or other gaseous carrier being correspondingly heated. It will of course be understood that the latent heat of the vaporized material, i. e., the heat which is released when the substance changes from the vapor to the liquid state, is considerable. In the preferred form of the invention the

spraying of the fatty acids and the utilization of the latent heat of the vaporized fatty acids are both made use of to obtain the desired result in the quickest and most economical manner.

In order that the invention may be more clearly understood, attention is directed to the drawing which illustrates certain forms of apparatus by which the process may be carried out. Figure 1 represents a diagrammatic side elevation of an installation in which the gaseous carrier is preheated by the utilization of the latent heat of the evaporated fatty acid and the fatty acids are sprayed in the still together with the gaseous carrier, certain parts being shown in cross section.

Referring to Fig. 1, the still 1 is preferably mounted over and heated from a furnace 2. A connection 3 extends from the top of the still to the top of what is termed a superheater condenser 4 which is connected at its bottom to a receiver 5, the latter being connected in usual fashion to an egg 6.

The receiver 5 is also connected by pipe 7 to a condenser 8 which is connected at its bottom to a receiver 9 which is also connected to the egg 6. A vertical connection 10 extends from the receiver 9 to the barometric condenser 11 which is connected by the water leg 12 to the hot well 13, and connection 14 also extending from the barometric condenser 11 to the vacuum pump 15.

In the form of the invention illustrated in Fig. 1, the steam or other gaseous carrier to be used enters the system through a pipe 16 which extends into the superheater condenser 4. This pipe extends through the superheater condenser in a suitable coil, and then extends from the superheater condenser by a pipe 16' which carries the gaseous carrier through a furnace 17. The steam or other gaseous carrier is superheated, or heated to a considerable degree by its passage through the coil in the superheater condenser, because of the passage of the hot vapors from the still over the coils in the superheater condenser. The gaseous carrier is still further heated by the furnace 17, if the pipe 16' is caused to extend through the same from condenser 4, the gaseous carrier passing by a connection 16'' into the lower part of the still, where it escapes through nozzles or vents 18.

The fatty acids to be distilled enter through a pipe 19 and are forced by pump 20 through a coil of pipe mounted in the furnace 17 from which point the heated fatty acids pass through pipe connection 21 into the still. Here they pass through nozzles 22 in the form of spray. These nozzles are arranged in such a manner that the sprayed fatty acids and the gaseous carrier are thoroughly and intimately mingled together. The heat conditions are so arranged as to cause the evaporation of the sprayed fatty acids, a temperature of about 450° F. being required. Preferably, the steam or gaseous carrier nozzles 18 are arranged immediately beneath the fatty acid nozzles 22. A tar outlet 23 is provided at the bottom of the still.

In the operation of the process a portion of the evaporated fatty acids passing over the pipe coil in the superheater condenser is condensed thereby, and an amount of heat equal to the latent heat of the fatty acids and steam condensed is imparted to the steam within the coil. Whatever fatty acids are not condensed within the condenser 4 will be condensed within the cooler condenser 8.

* Chemical Engineer, William Garrigue & Co. Letters Patent No. 3,372,477, Mar. 22, 1921.

Agricultural Insecticides

Uses, Economic Importance and Growth of Manufacture

By R. R. Henderson
Consulting Chemical Engineer

CULTIVATED crops always are more susceptible to disease and attacks by insects than were the wild plants from which they spring. The more highly developed become our agricultural products the more care is necessary to protect them against agencies which will hinder their growth. This is the reason that the manufacture of agricultural insecticides and fungicides has become a highly important industry.* Insecticides are used to protect crops of all kinds, field crops as potatoes and corn, fruits, and practically every plant grown in the truck gardens.

Pests Amenable to Insecticidal Control

Insects attacking plants may be divided into two classes, viz., chewing insects which actually bite or chew the foliage or fruit, and sucking insects which abstract the plant juices. Among the best known of the first type are caterpillars of all kinds, beetles and cut worms. These chewing insects are killed most easily by spraying a poison, usually an arsenic compound, over the plant so that when the insect feeds on the leaves he obtains sufficient of the poison to kill him.

For such insects Paris Green, London purple, lead arsenate, and recently calcium arsenate, are used.

Sucking insects have a sort of beak which they insert in different parts of the plant and feed upon the sap so that the vitality of the plant is exhausted and it dies. To this class of insects belong the various mites or scales and plant lice.

For sucking insects it is necessary to use some material which will kill by coming in contact with the body of the insect. For this purpose nicotine sulfate is the most popular. Lime sulfur solution also is used for certain scale insects, such as the San Jose scale which infest apple trees. But this solution is very strong and can be used only in the winter or early spring while the trees are dormant otherwise it would cause considerable damage to the tree. Other materials used in small quantities are soap and oil emulsions, tobacco dust and hydrocyanic acid gas, this latter principally for protecting orange trees in California.

What the insect ravages would be if they were not controlled by these means scarcely can be conceived. It is now practically impossible to grow field crops of many kinds or mature high grade fruit without their use.

It was only a few years ago that wormy apples were the common thing. Now a wormy apple on the market is a rarity. The codling moth or apple worm which cause this damage can be controlled entirely by spraying the trees, just after the petals fall, with lead arsenate.

The quantity of foodstuffs saved from insect injury by the use of toxic chemicals amounts to a large item in our agricultural economy.

The cost of raising farm crops lies mainly in preparing the ground, fertilizer, seed and cultivation, all of which is necessary weeks before the maturity of the crop. Any loss through insect attacks or disease is complete. That is, after the labor and raw materials

have been put into the ground the only way to get them back is by harvesting the crop. If there is no crop there is no possibility of partial salvage of the raw materials practicable in many industries. Therefore, the up-to-date farmer makes every possible insurance against failure.

The greatest advances to be made in this country in the next decade are to be accomplished by the elimination of waste, both of materials and of productive effort. Our abundant natural resources, combined with labor willing to operate our factories and farms long hours, have caused us to be somewhat careless in this respect. These conditions are changing. The doctrine of economy and efficiency is preached everywhere and in which the insecticide industry plays an important role.

That the government has already appreciated its importance can be seen from the fact that during the late war our agricultural insecticide plants were placed on the list of essential industries and were kept operating without interruption, government agencies taking care that they were well supplied with coal and raw materials.

The insecticide business got its real start when the Colorado potato beetle took up its journey eastward and began infesting the potato fields in the eastern part of the country. It was found that aceto-arsenite of copper or Paris green which is used as a green paint pigment and contains a high percentage of arsenic, could be applied to the potato vines to good effect in controlling the ravages of this beetle. This led to its use in destroying other insects on other plants. Considerable success was met with and before long more Paris green was being made for insecticide purposes than for use as a paint pigment. Soon after this the use of arsenic compounds in paints became unpopular and various chrome greens took their place with the result that for many years the production of Paris green has been practically for insecticide use only.

Another arsenic compound that was used to some extent on the potato beetle was London purple. Originally this was a by-product of the manufacture of certain dyes. Soon after its introduction as an insecticide the demand surpassed the supply available as a by-product and it was manufactured by another process for use directly as an insecticide.

The promiscuous use of these materials on all kinds of foliage soon caused trouble. It was found that certain proportions of the contained arsenic was soluble in water, would be absorbed by the plant and would kill the leaves and often the entire plant. The potato plant had been very resistant to this damage but many others could not stand the application of so much arsenic in water-soluble form.

At the time of the gipsy moth outbreak in Massachusetts it was suggested that arsenate of lead contained very little water-soluble arsenic and might be used to advantage. It was tried out and found suitable in many ways for this purpose. Besides being insoluble and thus practically harmless to very tender foliage, it also had another advantage over Paris green in that, in its finely divided form after drying from the spray solu-

*The succeeding article on "Agricultural Insecticides" will embrace "Raw Materials and Methods of Manufacture," "The Insecticide Industry," "Distribution," "Present Status of the Industry," "Problems to Be Solved."

tion, it adhered to the leaves and was not readily washed off by rains.

However, unlike Paris green or London purple, it was not already a staple article on the market. It could not be purchased anywhere, therefore, it had to be prepared at home by each user. The various agricultural experiment stations soon issued instructions for its preparation which consisted in mixing together solutions of sodium arsenate and lead acetate. This precipitated the insoluble lead arsenate and the whole mixture was then poured into the spray tank. It is evident of course that variable results were inevitable. The farmers had no means of knowing the purity of their raw materials; weights often were made carelessly; the chemical reaction often was incomplete; the precipitate was not washed but the whole mass dumped into the spray tank.

Notwithstanding all the difficulties attending its preparation, arsenate of lead grew in popularity. It could be used on nearly all foliage without danger of "burning," would cling to the vines through several rain storms, and had a high killing power.

Horticulturists and gardeners demanded a degree of permanence in the application of the insecticide, that this compound fulfilled.

Initial Insecticide Manufacture

The pioneer in its successful commercial manufacture was Cornelius D. Vreeland of Montclair, N. J. In February, 1906, he made application for a patent covering an electrolytic process for the preparation of arsenic compounds of lead. For several years his "Electro" brand manufactured in a little plant in Totowa just outside of Paterson, N. J., was the best known in the market. It should be mentioned, however, that not for long did this firm use the electrolytic process.

In searching the literature of arsenic compounds Mr. Vreeland noted in an early edition of Prescott & Johnson's "Quantitative Analysis," mention of the fact that arsenic could be determined by oxidizing it to arsenic acid by the use of nitric acid, then acting on it with lead oxide to form an insoluble lead arsenate which could be filtered, dried and weighed. This analytical procedure suggested to Mr. Vreeland the possibility of commercial production of lead arsenate by this method.

The method by interaction of sodium arsenate and lead acetate which then was being employed by several small plants and his own electrolytic method, were both expensive. Arsenic acid and litharge would be fairly cheap raw materials. Extensive experiments showed the process to be feasible and commercial production was started.

At about this time Elleslie E. Luther and William H. Volck of Watsonville, Cal., obtained a patent on the manufacture of lead arsenate by mixing arsenic acid and litharge with a catalytic material such as nitric acid to assist the reaction. Since that time many patents have been taken out and many methods proposed for making this article. Most of these proposed methods have proved worthless either on account of cost of production or low quality of product obtained.

There are several kinds of arsenate of lead possible. The original product was what is known as a triplumbic arsenate of lead and contained approximately 25 per cent. arsenic oxide. This was the material obtained up to the time of Mr. Vreeland's use of arsenic acid and litharge. This new method produced another arsenate of lead with an arsenic content of slightly

over 33 per cent. As it is the arsenic that gives the killing power this was a decided advantage.

Governmental Control

Like all industries with a wide demand, products were soon on the market of every quality, grade and strength. Finally to protect the farmers and assure their obtaining this essential materials of the proper grade the Department of Agriculture called a conference of the manufacturers and a committee was appointed to draft a law which would cover this situation. The now well known Insecticide and Fungicide Act of 1910 was the result.

The conference attempted to fix exact standards for but two articles, Paris green and lead arsenate, as these were the two products then constituting the bulk of the trade. It is required that Paris green shall contain at least 50 per cent. arsenious oxide and less than $3\frac{1}{2}$ per cent. of water-soluble arsenic.

The federal government with state cooperation, the former operating through the Bureau of Chemistry and the latter through their respective scientific officials, are charged with the maintenance of the standards set by this act.

At that time all lead arsenate was marketed in a paste form. It was not until the following year that Mr. Vreeland started another innovation by preparing the article as a dry white powder. It previously had been thought that the drying process would cause some decomposition or change in the product. Therefore the insecticide law standards required that arsenate of lead should contain not over 50 per cent. of water. It should contain at least $12\frac{1}{2}$ per cent. of arsenic oxide and less than $\frac{3}{4}$ of 1 per cent. of arsenic oxide in water-soluble form.

In the case of insecticides and fungicides other than lead arsenate or Paris green the law requires that the label shall contain no statement, design or device regarding the article which is false or misleading in any particular. For all insecticides containing arsenic it is required that the total amount of arsenic present be stated on the label and also the amount of arsenic in water-soluble form. It also provides that if the compound contain any inert ingredients which do not destroy, prevent, repel or mitigate insects or fungi the percentage of this inert material present shall be stated. Furthermore it shall be termed adulterated if it contain any materials which shall be injurious to vegetation when used according to directions.

The result of these regulations has been that Paris green and the lead arsenate, which has now practically superseded the former for nearly every purpose, were made standard articles of definite strength and could be purchased by farmers in the open market with entire confidence.

In this law as passed by Congress appears one very good joke. The committee who drafted it took as their basis of phraseology the Food & Drugs Act which had been enacted only a short time before.

In one sentence having to do with importations they neglected to make the proper change in wording and it was duly passed by Congress with no one noticing the error; so that the clause now reads "and if it appear that any insecticide . . . or fungicide to be imported into the United States is adulterated or misbranded within the meaning of this act, or is otherwise dangerous to the health of the people of the United States, the said article shall be refused admission."

A logical phrase incorporated in the Food & Drugs Act, but laughable when referring to poisonous insecticides as they all are dangerous to health and a strict in-

terpretation would bar all importation of arsenic into this country. But it is not enforced, everyone realizing that it is an error.

Growth of the Industry

The growth of the industry at first was slow. Besides the necessity of educating the farmers to the value of these materials it was difficult for new manufacturers to obtain knowledge of the required chemical processes to produce the goods.

As a usual thing it was only as employees left the original Vreeland plant or firms obtained licenses under the Luther patent, that new manufacturing plants were started. Every manufacturer kept his plant closely guarded believing he possessed a valuable manufacturing secret. Each factory manager felt that he had the most efficient methods. This attitude of secrecy continued for quite a few years. As a matter of fact all the plants were using practically the same process.

There were a few who on account of a lack of knowledge of certain features were producing an article which was not of extra quality. Material was produced which burned foliage on account of too high water-soluble arsenic-content or the product was too heavy to remain readily mixed with the water in the spray tank. These few black sheep not only harmed their own business but the trade as a whole for a time.

Here is a good example of one of the evils of manufacturing secrecy. It would have been far better for the business as a whole if their competitors had gone frankly to these backward firms and showed them how to improve their product. The backward firms themselves never would have had the nerve to ask openly for information, for strange as it may seem it was usually these very firms themselves that maintained the strictest secrecy.

This attitude of secrecy was banished once and for all a few years ago after the writer had designed a plant for the Glidden Co. of Cleveland. Adrian D. Joyce, president of this concern, appreciating the full

value of publicity over secrecy, cooperated in freely inviting customers, manufacturing competitors and any others that might be interested to inspect the plant and processes.

This was taken advantage of to such an extent as to lead Mr. Schorndorfer, the general manager, facetiously to suggest that we erect a grand stand at one end of the plant.

The manufacture of Paris green has dwindled to small proportions. The chief insecticide now employed for chewing insects is lead arsenate. During the last four years there has been a demand from some sources for an insecticide which would kill more quickly than lead arsenate and yet would be comparatively free from burning effect on foliage.

Calcium arsenate has been developed to fill this demand. This compound contains almost as much arsenic and consequently has nearly the same killing power as Paris green. In addition it is quite insoluble and is, therefore, almost as safe to use on many kinds of foliage as lead arsenate. Being slightly soluble, however, it cannot be used on vegetation promiscuously with entire safety as can the lead compound.

The chief field for calcium arsenate has been found in combating the cotton-boll weevil in the south. It is estimated that over 10,000,000 pounds of this material was shipped into the southern states to protect the cotton crop last year.

There are 2,500 manufacturers of insecticides in the United States but practically all of these are makers of small specialties for household use, put out under trade names in a manner similar to the so-called patent medicines. There are only about seventeen firms in the country actually manufacturing arsenate of lead, arsenate of calcium, nicotine sulfate and their compounds in quantity for general agricultural use. Many of the largest producers are paint companies who have taken up the manufacture in connection with their dry color departments. From a manufacturing standpoint this is quite logical as similar apparatus is used for both lines.

National Lead Co. and Titanium Oxide

In his annual report of the National Lead Co. President E. J. Cornish discusses the experience of his company during the slump in the last half of last year and finds some satisfaction in that similar conditions prevailed in all other lines. Sales of oxides of lead, used largely by manufacturers of electric storage batteries and the rubber industry, fell off 70 per cent. in one month and are still 50 per cent. below normal. The sales of babbitt metal, which increase or decrease in proportion as the wheels are turning in factories—and, in fact, the sales of all metal products—have fallen off more than one-half. The encouraging feature of all this is that the hesitancy of customers to place orders with the company in excess of immediate requirements indicates a conservatism and prudence that augurs well for the future.

In past financial crises, the first effect of unemployment has been an increase in the consumption of lead in oil. It is estimated that from 75 per cent. to 85 per cent. of paint is consumed in repainting and repairs, and only 15 per cent. to 25 per cent. in new construction. We have every reason to expect an increasing demand for white lead. Our present sales, of course, only show the expectation of dealers as to what the consuming demand will be, but it is encouraging to note that our sales of lead in oil for the first two months of 1921 are considerably above the average since 1912.

Our company became the owner of all patent rights

in the United States previously owned by the Titan Co. of Norway. Where great hiding power without increase in weight is desired, titanium oxide should prove to be very valuable. Its cost of manufacture is still high, but it is hoped that, with increased tonnage and improved manufacturing methods, this pigment will soon take its place amongst the best and most marketable white pigments. It is the policy of the National Lead Co. to be the first to inquire into, become interested in, and promote the sales of new inventions of this kind.

Chemists for Chemical Warfare Service

Chemical Warfare Service, Edgewood Arsenal, Edgewood, Maryland, will appoint fifty chemists as soon as suitable men can be secured. The United States Civil Service Commission has announced that until further notice it will receive applications for these positions in the following grades: Chemist at \$3,000 to \$5,000 a year, associate chemist at \$2,000 to \$3,000 a year, and junior chemist at \$1,400 to \$2,000 a year. Promotion from the lower to the higher grades will depend upon demonstrated ability and the needs of the service. The examination announcement states that there are opportunities for employment in fifteen specialties of chemical science. Full information and application blanks may be obtained from the U. S. Civil Service Commission, Washington, D. C.

Cooperation of Education and Industry

The Eastman Kodak Company

One of the Foremost American Products of the Copartnership of the Technical School and the Manufacturing Organization

THE construction of building No. 52, of steel, brick and concrete, 114 ft. wide, 365 ft. long and 75 ft. high, for the manufacture of photographic film, at the Kodak Park Works of the Eastman Kodak Co., is the expression of the enterprise of an industry that rises supreme to economic depressions because it is predicated on pleasures that have become a part of the people's necessities.

The Eastman Kodak Co. in many respects is one of the most unique organizations of modern industry, chief of which is its personnel and its intimate relation and dependence upon education in applied science, for from this characteristic flow all other attributes that make it notable in its rare opportunism.

The creation of the photographic industry and the transformation of the practice of photography from a professional art to an amateur pastime, with its important industrial, commercial and educational applications, are the work of one man who drew about him in the development of its business throughout the world many technical men whose alertness and loyalty he rewarded not only directly in the present, but for all time made possible their propagation in his endowment of institutions devoted to their training and from which he draws to expand his administrative and research personnel to meet the world-wide demand for his products.

The organization in Rochester embraces the Kodak Park Works covering 225 acres, including 18 acres in landscape development, in which are manufactured by over 6,500 employees on 80 acres of floor space in 114 steel and concrete buildings the basic materials essentially chemical of photographic merchandise.

In addition to film, photographic paper, dry plates, chemicals and developers, are made raw paper, gelatine, nitric, acetic and sulphuric (contact) acids and numerous mechanical accessories of the business. The consumption of silver bullion, second only to that of the U. S. Mint, for the production of silver salts sensitive to light; the use of raw cotton to make



FRANK W. LOVEJOY
'94 Chemical Engineer, Mass. Institute of Technology.
Vice-President and Member Board of Directors.

cellulose nitrates and acetates, the foundation of the film; the inventive ingenuity displayed in machine construction peculiar to the art and the general employment of machinery wherever the human hand can be eliminated, are outstanding impressions of this remarkable institution; second, however, to the unmatched display of specialization and coordination in industrial management wherein the hand of management, conspicuous in its apparent absence, is disclosed in the devotion of each man and woman to his or her job.

To the observant visitor to Rochester's most famous factory, the most notable thing is the high morale of the help expressed in an operating mechanism that runs without jolt or jar subject to the ceaseless scrutiny of technically trained men, from which is reflected a loyalty that should be the pride and ideal of every production manager.

Other local plants comprise, in addition to a 16-story office building, the Camera works with a floor area of 8 acres, the Premo works, the Century-

Folmer and Schwing plants, and the Hawkeye works devoted to lens manufacture.

Few industries surpass the photographic industry in its dependence upon applied science. Recognition of this fact is expressed in the maintenance of one of the largest scientific and technical research organizations in the United States.

Of a staff of 120 people, 45 are chemists, physicists and photographic experts; 70 members devote their entire time to the theory of photography, the development of new photographic materials and methods, and the theory of manufacturing processes. Under the directorship of Dr. C. E. K. Mees, not only has the Eastman Research Laboratory taken a high place in the development of pure and applied science in photography and allied subjects, but has been notable in its efforts to supply American scientists with research chemicals heretofore procurable only from Germany.



CHARLES F. HUTCHISON
'98 Chemist, University of Rochester,
Supt. Film and Plate Emulsion
Manufacture, Kodak Park Works.



ALBERT F. SULZER
'01 Chemical Engineer, Mass. Institute of Technology.
Assistant Manager in Charge of
Production, Kodak Park Works.

Under the decision of the U. S. District Court at

Buffalo in a complaint under the Sherman Anti-Trust Act, handed down Jan. 9, 1916, the company now agrees to sell within two years (1) the Premo, Century-Folmer and Schwing factories, together with the machinery and equipment, (2) the Artura brand of photographic paper and its Seed, Stanley and Standard

brands of dry plates, and (3) to disclose to the purchasers of these brands the formulas for their manufacture. The value of the property to be sold is estimated at about 4,000,000, compared with about \$90,000,000, the estimated value of the company's properties as a whole.

This penalty for efficiency in an art and business that contribute in an unrivalled way to popular education and social progress involves the separation from the parent organization of the working forces attached to the plants to be sold and of their participation in the

this will be done. As regards cameras made in the plants ordered to be sold, competing lines cannot be brought out immediately, as the decree of separation calls for the sale of plant, equipment and goods in process, as well as trade names.

The chief of this organization which has brought renown to Rochester and who today is its foremost citizen and philanthropist, remarked twenty years ago: "We can hold our position in the trade just so long as we make better goods than the other fellow and no longer"; which statement not only is compact with the philosophy of modern industrial progress, but reveals the practical-minded man who accepts his success as a stewardship and who bestows its results to increase industrial efficiency and to adorn life.

At an abrupt turn in a passageway in a building of the Kodak Park plant we bumped into a comely young woman. In the mutual embarrassment of disengagement from an enforced embrace we said: "Aren't you glad you work for George Eastman?" She stood off blushing and with winsome emphasis replied: "Yes, sir! I certainly am."



JAMES H. HASTE
'96 Chemist, Mass. Institute of Technology.
General Manager, Kodak Park Works.



HENRY H. TOZIER
'96 Chemist, Mass. Institute of Technology.
General Superintendent, Sensitized Paper Departments, Kodak Park Works.

advantages of membership.

The purpose of the Sherman act is to provide for the widest possible competition. The parent company is not prohibited from making photographic paper and plates in competition with the segregated brands and



Aerial View of Kodak Park Works, Eastman Kodak Co., Rochester, N. Y.

New Plant of Atlantic Dyestuff Company

HERBERT S. KIMBALL, A.S.M.E., mill engineer, 75 State street, Boston, Mass., in cooperation with the production managers of the Atlantic Dyestuff Company, is responsible for the design and construction of its new dyestuff plant on the Piscataqua River at Newington, N. H.

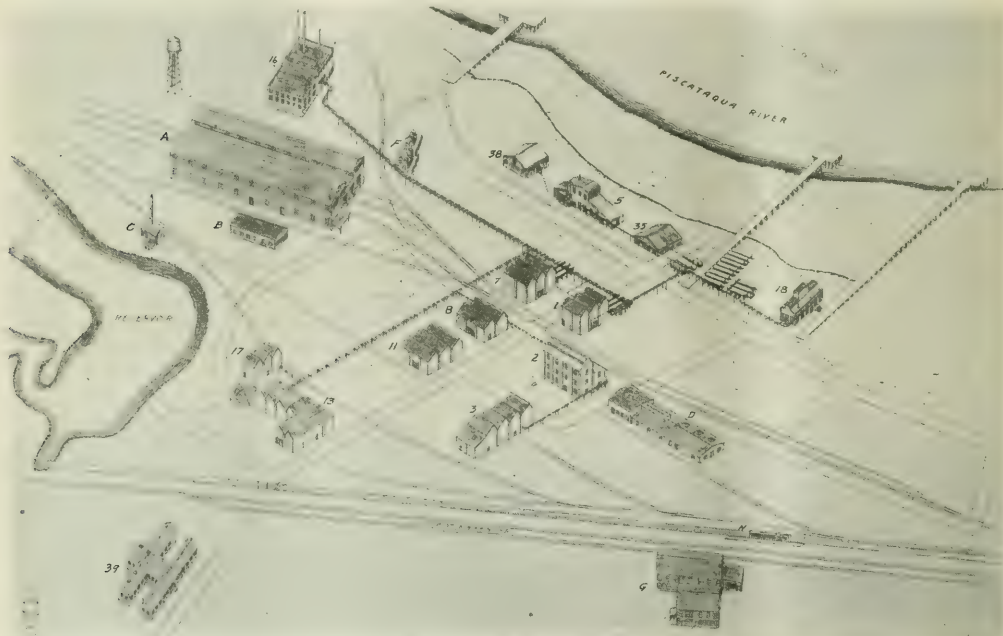
On the site selected was an extensive system of railroad tracks, several buildings that could be used, and three piers making out into deep water, where ocean-going cargo craft may come alongside. Studies of the future growth were made both as regards the equipment installed last year and that for other processes in contemplation.

In cooperating with the owners and the insurance inspection board the type of building was studied as

Fire protection equipment is being laid out by the underwriters in charge of that territory. It is interesting to note that in the chemical manufacturing buildings, sprinklers are not to be installed.

In studying the layout the aim was to devote a single process to one area. Its location was selected with due regard to the degree of hazard of the process, as well as its contiguity to the next stage of the process of manufacture. The existing piers, extending out to deep water, and the system of tracks, offer facilities for unloading raw material and shipping finished products. These existing physical features had considerable bearing on the location of the storehouses for raw material and in turn on the location of the various processes.

Following is a list of the buildings indicated by



regards permanence, ease of enlargement, fire and explosive hazards, cost, interior lighting during daylight hours, ventilation and upkeep. A standard type was adopted and several buildings were erected.

The dye manufacturing buildings are of one story with walls of terra cotta tile; the roof loads are carried on reinforced concrete pilasters, which give the rather high walls the desired stability and take all the load off the terra cotta tiles.

The accompanying isometric view of the works shows the wooden framed saw-tooth roof and also it will be observed that there are no windows in the walls of this type of building. The light and ventilation are obtained through the roof.

The area of one unit of the dye manufacturing buildings is not over 5,000 square feet; three units will be the final number to constitute one building. There was adopted as a minimum a space of 40 feet between buildings, but in some cases there will be 60 feet.

There are some buildings that do not conform to the standard type, which were designed especially to meet particular requirements.

numbers and letters whereby their location in the plant can be determined by reference to the isometric view.

Standard Type of Construction: 1 and 7, nitration; 2, distillation—this building has a steel frame instead of reinforced concrete pilasters; 3, reduction; 8, grinding and drying; 11, storage; 13 and 17, sulphur colors (sulphur colors under construction).

Special Buildings: 16, boiler house—modern steel frame structure, at present with temporary roof and walls; 5, nitric acid plant; 18, sulphuric acid recovery plant.

As regards 5 and 18, plans are ready to start construction which involves wood frames with corrugated asbestos cement siding and roofing.

Proposed construction embraces a (35) mixed acid house; (38) storage for nitrate of soda, and (39) laboratory.

Other structures indicated on the diagram are: A, storage; B, compressors; C, boiler house; D, shops; F, hospital; G, hotel; and H, railroad station (Boston & Maine R. R.).

Manufacture and Properties of Fish Glue

By Donald K. Tressler, Ph.D.

Industrial Fellow of the Mellon Institute of Industrial Research of the University of Pittsburgh

MANY manufacturers using large quantities of glue prefer a glue prepared in such a form that it is ready for immediate use, but continue to use other glues because they are not certain of the quality of the liquid glues on the market. Comparatively few chemists are familiar with the proper methods of testing liquid glues. The method of determining the quality of hide and bone glue by viscosity tests, jelly strength determinations and water absorbing power are widely known and are considered reliable tests. Comparatively little has been written concerning the methods of testing fish glues and other liquid glues although these glues vary more widely in quality than hide and bone glues.* In the following article the methods of manufacture and testing of fish glue, and its composition, properties, and uses have been considered. The writer hopes that this discussion may create a more general conception of the methods of testing fish glue and a broader knowledge of its properties and uses.

Fish glue is marketed usually in the form of liquid glue and it is the most important liquid glue. Dry fish glues are soluble in water at ordinary room temperatures, whereas hide and bone glue merely swell but do not dissolve under these conditions. Hide and bone glues are occasionally made into liquid glues; but, in order to do this, the hard glues must be either dissolved in a solution of a gel-inhibiting substance or so treated that their chemical composition and properties are changed.

Source of Raw Materials

The bulk of the fish glue manufactured today is made from the waste products of the cod, haddock, cusk, hake and pollock industries. These fish are the so-called "ground" fish which are caught on the banks, usually together in the same nets, and cleaned on the same wharves. Consequently, most of the fish glue stock comes to the glue factory already mixed, i. e., the waste from the various species of fish have been dumped into the same containers.

Some other species of fish than those mentioned above are used in the manufacture of glue—indeed, any fish might be used for the making of glue—but for certain practical and economical reasons only small quantities of glue are manufactured from other fish. The quality of glue prepared from these ground fish is higher and the yield greater than in the case of glue made from most other fish. Many species of fish—e. g., menhaden—yield such small quantities of glue that it is not economically practicable to use them. Other fish, e. g., herring and mackerel contain such large quantities of fat that special procedures must be followed to remove the fat from the fish in the glue-making process. Many fish which would otherwise be used are not caught largely in any one locality and consequently the supply of fish waste at any particular point is not large enough to justify the establishment of a glue fac-

tory. Other fish are caught only for short seasons, which would cause the glue factories to be idle most of the year.

The ground fish waste ordinarily is divided into three classes, viz.: (1) fish heads; (2) waste, i. e., salt fish trimmings and bones; and (3) skin from the dried salted fish. The fish heads are fresh and are hauled from the wharves where the ground fish are cleaned. With the exception of the exported salt fish, most of the dried salt fish is skinned before it is packed for shipping. The cod and cusk skins are not mixed with the skins of the haddock, hake, and pollock. The cod and cusk skins which have a small amount of salt-fish adhering to them constitute the skin-glue stock. Most of the salt-fish sold in this country is cut into strips, trimmed of the outer yellow portion and freed from bones. The trimmings, bones, and haddock, hake and pollock skins constitute the salt-fish waste glue-stock and is termed "waste."

Methods of Manufacture

The glue stock, regardless of its source, must be freed from salt or freshened before being made into glue. The fish skin and waste stock, being a waste product of the salt-fish industry, contain a much greater percentage of salt and consequently more care must be used in freshening it than in freshening the fish-head stock. The fish skin and waste stock ordinarily are agitated in running water in large tanks for a period of 12 hours or more, or until a sample of the wash water on analysis shows a low percentage of chlorides. The stock is then thrown into false-bottomed tanks, called "cookers," which usually have a layer of excelsior on their false bottoms. The stock is covered with water and a slow stream of steam is passed into the tanks. The length of the cooking period varies with the nature of the glue stock; fish waste requiring longer cooking than fish-skin stock. Usually two runs are made; that is, the liquor formed by the cooking of the stock is drawn off when it becomes sufficiently concentrated, more water is added and the cooking is continued. The average concentration of the glue liquors is about 5 per cent. The first run of glue liquor is the better.

After from 6-10 hours' cooking, when nearly all the glue has been removed from the stock, the cooking is stopped and the second run of glue liquor is withdrawn. The residue in the cookers usually is put in large hydraulic presses, where most of the remaining glue liquor is pressed out. This press glue liquor is added to the second run liquor.

Preservatives are added to the glue liquor to prevent any bacterial action. Fish glue and glue liquors decompose very rapidly if any considerable amount of bacterial growth in them is permitted. The preservatives added by various glue makers include phenol, cresol and boric acid. The finished product contains from 2-4 per cent. of preservatives, depending upon the nature of the preservative added.

The glue liquor, drained from the cookers, next is pumped to the evaporators. The types of evaporators used vary in different factories. Some plants

*This article will constitute the basis of a discussion upon fish glues which will appear in "The Chemistry and Technology of Gelatin and Glue" by Dr. R. H. Boege and co-authors, McGraw-Hill Book Co. This book is one of the Technochemical Series, edited by the Mellon Institute of Industrial Research.

use open pans heated with steam coils; others use open pans containing revolving copper coils; and still others use vacuum pan evaporators. The glue liquors usually are strained through a coarse wire screen. The liquors are evaporated to a uniform viscosity, and just before the glue is run into the storage tanks, a sufficient amount of some essential oil, as cassia, camphor, clove, wintergreen or sassafras, dissolved in ethyl alcohol is added, to prevent the growth of moulds. These essential oils not only prevent the growth of moulds, but mask the odor. Some fish glues also are made opaque by the addition of zinc white or some other white pigment.

The process by which the fish heads are converted into glue usually are kept more or less secret. It may be stated, however, that the processes are for the most part similar to that outlined above, except that the glue stock is digested with dilute acids, usually hydrochloric or acetic acid, instead of cooking with steam alone. Moreover, the stock and glue liquors usually are bleached well. Sulphur dioxide and sodium bisulphite are the common bleaching agents. Fish-head glues generally are made opaque with a white pigment.

The residue, "chum," from the hydraulic presses is dried and marketed either as chicken-feed or as a fertilizer, and contains approximately 50 per cent. of protein. Then, too, the fish head and waste chum contain a high percentage of calcium phosphate which supplies lime for the egg shell and phosphorous for the egg yolk.

Various fish-glue makers market their glue in different ways. Some cater to the trade buying liquid glue in bulk, others market it chiefly in small bottles and cans. The following three grades can be purchased on the market: (1) photo-engraving glue which is made from the first-run glue liquors from fish skin; (2) fish-skin and fish-waste glue which is usually sold in small bottles and small cans; (3) fish-head glue, which is prepared from fish heads ordinarily is marketed in large cans and barrels.

Practical Tests to Determine the Quality of Fish Glue

Fish glue of the ordinary viscosity contains from 50-55 per cent. of glue and weighs from 9½-10 pounds to the gallon. There is a considerable quantity of fish glue on the market which is of rather doubtful quality. Consequently, if the glue-user does not test his glue, it is wise to buy only from manufacturers with well-established reputations.

The best fish glues have a gel point of about 75°C. A higher gel point is satisfactory in warm weather, but is unsuited for outdoor use in cool weather. Fish glues should not contain more than 0.2 per cent. of sodium chloride, as a higher salt content indicates a poor drying, hygroscopic glue which, while affording satisfactory joints in cool dry weather, probably will weaken in humid weather. All fish glues should be slightly acid to litmus.

The drying test is carried out preferably by spreading a uniform layer of glue, about ⅛ inch in depth, on a glass plate and placing the plate in a constant-humidity and temperature room, together with a similar layer of a standard glue of known hygroscopic properties. A room having a constant temperature of 20°C. and a constant-humidity of 50 per cent. will be satisfactory. The time of drying and the hardness of the dried film are noted and compared with the standard. The dried films then

should be placed in a room having a higher humidity and temperature. A very exacting test may be conducted by choosing a room having a temperature of 25°C. and 80 per cent. humidity. Under such conditions most fish and bone glues will soften slightly. If the dried glue film becomes liquid or sticky under these conditions, a poor glue is indicated. If constant temperature and humidity rooms are not available, large humidors containing sulphuric acid of the proper dilution may be used.

The joint-strength tests, as ordinarily applied, are not of much value in determining the quality of a given sample of fish glue, inasmuch as the temperature and humidity at which the tests are conducted are the controlling factors in the strength of the joints. The personal equation is also an important factor which should be considered in comparing results of joint tests. However, if the laboratory worker conducts all the joint-strength tests under the same conditions of temperature and humidity, the results of these tests become valuable. The results are particularly useful if these tests are made under humid conditions. A constant temperature and humidity room should be so regulated that the temperature is in the neighborhood of 25°C., and the humidity about 60 per cent. The wooden blocks and the joints should be kept in this room or in a humidor having similar conditions of temperature and humidity. Under the conditions mentioned above, good fish skin and fish-waste glues possess about the same tensile strength as high-grade bone and low-grade hide glues, whereas fish-head glues are about as strong as medium-grade bone glues.

Composition

Until more work has been done on the composition of fish glue, a complete analysis of the fifty per cent. of dry matter contained in liquid fish glue will be of little value in indicating the quality of the glue. Fish glues differ in composition from hide and bone glues, in that fish glues are composed chiefly of proteoses and peptones with a smaller proportion of proteins, whereas the higher grade of hide glues are nearly pure gelatin, and bone glues consist mainly of gelatin and proteoses. The proteins of fish glue are higher in ammoniacal nitrogen, melanin and non-amino nitrogen than the proteins of either hide or bone glues. The composition of the proteins of fish glue resembles more closely that of the proteins of bone glues than that of the proteins of hide glues.

Dry fish skin and fish waste glues contain about one per cent. of ash. The amount of ash contained in fish-head glues varies widely, depending on the method of manufacture used and the amount of pigment or other inorganic material added during the manufacture of the glue. Samples analyzed by the writer contained from 1-5 per cent. of ash in the dry glue. A representative analysis of a sample of ash from a fish skin glue is given below:

ANALYSIS OF ASH	
Ash in dry matter.....	0.96%
Silica (SiO ₂).....	12.7%
Calcium oxide (CaO).....	10.5
Magnesia (MgO).....	trace
Potash and soda (K ₂ O and Na ₂ O).....	13.9
Sulphur trioxide (SO ₃).....	34.0
Phosphorous pentoxide (P ₂ O ₅).....	24.9
Chlorine (Cl).....	3.2
Ferric oxide (Fe ₂ O ₃).....	trace
	99.2%

Properties

The color of liquid fish glue depends upon the nature of the raw material, the method of manufacture and the clarity of the product. Fish-skin glues, as they are ordinarily produced, are the clearest. Fish waste and fish-head glues are more or less opaque. Most clear fish glues make a dark joint when used with light-colored woods, and consequently much of the liquid glue on the market contains some white pigment. This gives the glue a lighter color and also makes the joint less conspicuous.

The odor and taste of fish glues depend largely upon the nature and amount of preservatives and essential oils added. Upon heating for some time, the essential oil is driven off and the true odor of the fish glue becomes more apparent.

The "speed of set," or the time elapsing after the application of a coat of glue until the glue becomes a gel, depends upon the gel point and viscosity of the liquid glue, the amount of glue applied, the nature of the wood, and, also, to some extent, upon the humidity of the atmosphere. "Setting" is caused by a partial withdrawal of the moisture in the glue, thus causing the gelling of the liquid glue. The higher the viscosity and gel point of the liquid glue, the less the amount of glue applied, the more absorbent the surface to which the glue is applied, and the lower the temperature and humidity of the atmosphere, the more rapidly does the glue "set."

At any given temperature and humidity the rate at which the fish glue dries depends upon the source of the glue, the method of manufacture and the salt content. As a rule, fish-skin and waste glues dry more rapidly than fish-head glues, although if the fish skin and waste glues contain an abnormally high salt content this may be reversed.

The viscosity of liquid fish glue depends upon the source of glue, the method of manufacture, the percentage of dry glue in the liquid glue, the temperature, and the addition of substances other than fish glue, e. g., boric acid, hard glue, phenol and cresol. The addition of boric acid increases the viscosity of liquid fish glue to some extent; whereas the addition of phenol and cresol decreases the viscosity. Small amounts of hard glues, i. e., animal glues, sometimes are added to increase the viscosity.

Fish-head glues are usually more flexible than skin and waste glues. Glycerine and glucose often are added to increase the flexibility of glues.

Properly preserved liquid fish glues will keep indefinitely in an air-tight can or well-stoppered bottle. If the glue is stored in a cold room it will gel. This gel melts quickly as soon as the glue has been warmed above its gel point. When liquid glue containing phenol or cresol is put up in tin cans, after a time a black ring is formed around the top of the can where the phenol or cresol has attacked the iron. However, this does not injure the quality of the glue. Precipitates sometimes settle out from poorly prepared liquid glue, but this settling does not injure the strength of the glue.

Uses

No other glue on the market has as many or as varied uses as has liquid fish glue. The best grade of fish-skin glue is the only satisfactory glue which can be used for the production of half-tone plates for photo-engraving work. It is also used to some extent in the production of zinc line plates for photo-engraving work. Fish glues are used largely where flexible glues are required, e. g., in the manu-

facture of court plaster, labels and stamps, and in the binding of books. Where small amounts of a strong, ready-to-use, adhesive is needed, fish glues are universally used, e. g., for small repair jobs about the house, for shoe repairing and general repair work. Some fish glue is blended with hide glue and used as belt cement for leather belts. Large quantities of fish-head glue are used in various sizing operations, for this glue stiffens materials yet is somewhat flexible. Some fish glue is used in the chipping of glass in the production of translucent glass. Large quantities are used in box-making, furniture making, and for general joining work.

New Jersey Chemical Society

The regular monthly meeting of the New Jersey Chemical Society was held on Monday evening, May 9, at Stetter's restaurant in Newark. After a well-attended dinner, the diners supplemented by an assembly that filled the adjoining auditorium listened to Dr. Marston T. Bogert, professor of organic chemistry, Columbia University, discuss "Scientific Preparedness."

Dr. Bogert is a publicist, a rare character among chemists. Understanding economics as well as chemistry, his advocacy of the destruction of the German dyestuffs monopoly by the dispersion, development and protection of the industry in all advanced manufacturing nations, particularly in the United States, does not disclose the erraticism exhibited by those who advocate the destruction of the German dye plants themselves. By numerous citations of Germany's solicitude in developing and conserving her dyestuff industry in all its ramifications he drove home the absolute necessity for our own future safety of similar solicitude on the part of our own government as regards our dyestuffs industry.

Dr. Bogert's address was followed by the remarks of Colonel C. Otwell, commandant of the Lakehurst, N. J., proving grounds of the Chemical Warfare Service, who from the standpoint of an army officer upheld Dr. Bogert's contentions and declared they should be the faith not of industrialists alone but of all Americans.

John F. Thompson and R. L. Suhl of the technical department of the International Nickel Co., Bayonne, N. J., discussed the technology and uses of nickel, its alloys and compounds, and described the manufacture of Monel metal.

John F. Bryden, chairman of the membership committee, submitted the names of 32 new members and announced a total membership of the society of 704 with early prospects of attaining 1,000. He proposed for honorary membership Mme. Curie whose unanimous election as a member of the New Jersey Chemical Society confers honor on them both.

Corporate membership was granted the Magnetic Pigment Co., Trenton, N. J., Dr. Peter Fireman, Menlo Park, N. J., representative, a subsidiary of Binny & Smith, 81 Fulton St., New York.

H. H. Wilson, formerly with the Westinghouse Electric & Mfg. Co., has joined the staff of the Abbé Engineering Co., 50 Church St., New York. Mr. Wilson also has been chief engineer of the Colorado Electric Power Company and superintendent of the Ontario Power Company and its subsidiaries and has had considerable experience with machinery in chemical and electro-chemical plants.



A View of Manufacturing Area Nashville Industrial Corporation's Peace-Time Development of Old Hickory, Jacksonville, Tennessee.

Peace-Time Industry at Old Hickory

A Survey of the Transformation of the World's Greatest Powder Plant to Peace-Time Uses

THE immense sums expended by the government in the construction of munition plants which the termination of the conflict earlier than the construction programs anticipated found their products unnecessary and the plants in varying degrees of incompletion, have created a problem in the transformation of war enterprises to peace-time uses that ranks in present domestic economics with the production problems of the war. The latest and largest of these war enterprises to engage the attention of industrialists is the "Old Hickory" smokeless powder plant built at Jacksonville, Tenn., 18 miles from Nashville, on the navigable Cumberland River. Here the DuPont Engineering Co. at an expenditure of \$85,000,000 built for the government on an 1800-acre tract 1,021 completed buildings of all types devoted entirely to manufacturing. The housing section of the development comprises 3,020 buildings on 560 acres, capable of accommodating 30,000 people—the combined manufacturing and housing sections constituting the most gigantic enterprise of its kind ever undertaken. The total area of the reservation is 4,706 acres. Construction was started in March 1918, and suspended in November of the same year. At the cessation of hostilities construction work had progressed to 95% of completion and production had reached 50% of the maximum proposed capacity.

The transformation of this immense construction and multiform equipment to peace time uses of a chemical and allied character is a job requiring on one hand the long-sighted view of prudent capital and on the other the help of the chemical engineer alert to the opportunities of low-cost production.

The Nashville Industrial Corporation which acquired the plant from the government, comprises in its official personnel H. G. Hill, president. Mr. Hill was president, 1920, of the Nashville Chamber of Commerce, and is president, Phillips-Trawick Wholesale Grocery Co. and of the H. G. Hill Grocery Co., of that city, operating a chain of 87

stores in the South. G. E. Bennie, vice-president, is president of the Alexander Bennie Co., wholesale supply dealers, Nashville. Saul M. Davis, treasurer, is vice-president of the American National Bank of Nashville. T. L. Herbert, secretary, is of T. L. Herbert & Sons, building supply dealers and contractors, also of Nashville. B. P. Morse, general manager, is treasurer of Morse Bros. Machinery & Supply Co., Denver, Colo. A. W. Phillips, director of the industrial department of the Corporation, is head of Chemical Industries, Inc. of New York.

Within a 500-mile radius of Old Hickory live 42,000,000 people, with cheap and direct transportation to Gulf ports, and with abundance, variety of and accessibility to raw materials unmatched in America. The utilization by manufacturing organizations of the structures and equipment here available will be encouraged by low production costs.

The development of the manufacturing possibilities of the plant under conditions of peace demanded the study of chemical engineers. Meigs, Bassett & Slaughter, Inc., Philadelphia, Pa., was called upon to investigate and report the maximum availability of the production facilities. This organization divided the plant site into the following areas:

Chemical Area	Foundry, Machine Shop and
Pulp and Paper Area	Box Factory Area
Light Manufacturing Area	Dye and Bleach Area
	Lacquer and Artificial Leather Area

The industries that the engineers suggested should be located on these areas were recommended after a careful study of the natural resources of the country surrounding Old Hickory, together with the buildings, apparatus and equipment that would be available. A chart was made showing how these basic industries would co-ordinate with light manufacturing plants, which is reproduced herewith. Industrial concerns considering location at Old Hickory comprise about every department of manufacture. Among those already located may be mentioned the Davison Chemical Co., Baltimore, Md.,



A View in the Housing Area.

which is operating at present one sulphuric acid unit with the intention of taking over additional units in the near future. Its new substitute for platinum mass in the converters is reported to be quite successful.

Mead-Johnson Co., Evansville, Ind., will take over buildings and equipment used in cotton purification and smokeless powder drying and will engage in the manufacture of starch and syrup from sweet potatoes, of which it has planted 100 acres and will buy in the open market. The pulp left after the starch extraction will be turned into cattle-feed. Operation will begin with the canning crop.

Stergian Repeating Arms Co., Chicago, D. Stergian, president, has taken over certain buildings and equipment in the shops area and will manufacture sporting rifles, shotguns, rapid-fire army rifles, revolvers and novelties. The company is now installing equipment and expects to start production June 1st.

Old Hickory combines a southern position with a high average altitude, rendering the climate one of the most equable and delightful in the United



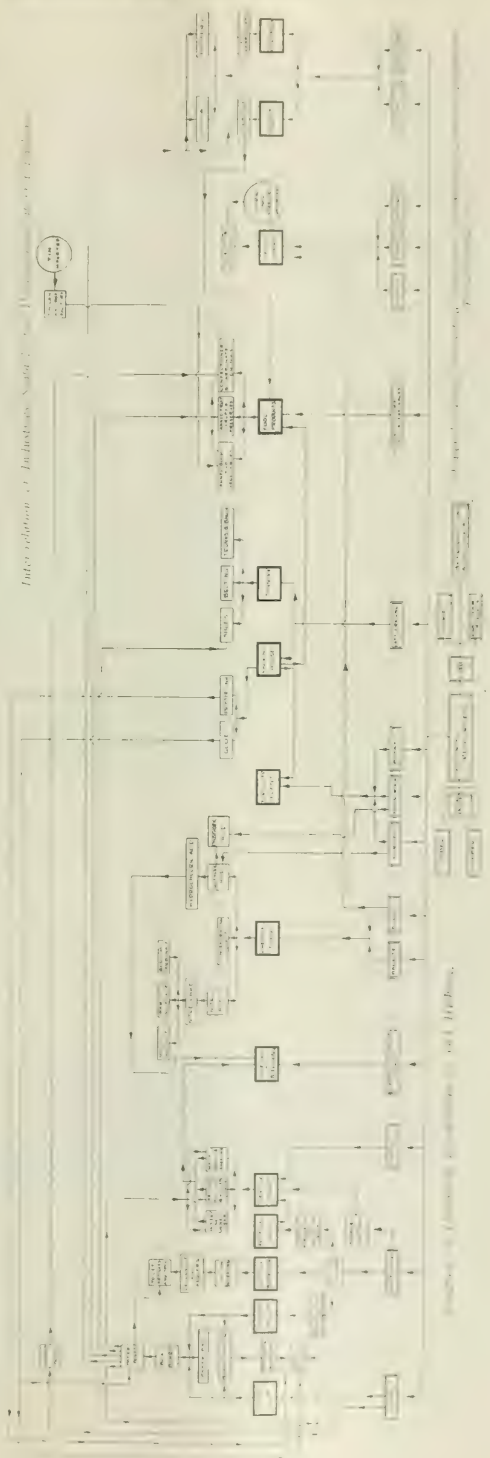
States. It is never too cold or too hot for work out of doors; the winters are short and the several seasons of the year are free from the extreme high and low temperatures that interfere with normal business activities and labor efficiency.

Transportation facilities comprise three trunk line railroads, the Tennessee Central, Nashville, Chattanooga and St. Louis, and the Louisville and Nashville. Old Hickory's proximity to Nashville includes it within the Nashville terminal district, giving it the same freight rate as Nashville. The navigable Cumberland river affords opportunity for transportation by boat to the entire Mississippi and Ohio valleys and up stream to the rich undeveloped territories of Kentucky.

The Nashville Industrial Corporation maintains a traffic expert to give prospective purchasers of Old Hickory property any specific data desired on shipping facilities and traffic costs and to render assistance to industries with their shipping problems.

The Nashville Industrial Corporation does not attempt to underwrite any industry, but offers instead, ideal factory sites, splendid factories and equipment and utilities at such reasonable prices and terms that they constitute a more practical assistance to a manufacturer than he can procure elsewhere. It stands at all times ready to aid Old Hickory's industries in every way possible and

maintains men in its organization who are qualified to solve and assist with industrial problems.



The Container in the Growth of Chemical Manufacture

The Pfaudler Company

A Description of Its Service to the Chemical and Allied Industries.

IN the manufacture of the immense variety of chemical compounds used in the arts and of edible products that require equipment for effecting the many process changes which shall be inert to the reacting material, the influence of the container, whether it be the reaction vessel, the pipe-line or the storage tank, is of a character that warrants the observation that the container itself profoundly has influenced the course of chemical manufacture.

In the development of many lines of chemical manufacture in America, particularly the dyestuffs industry in the haste and press of war-time, the production of equipment refractory to the corrosive action of the materials used was a condition precedent to the production of the finished products themselves. Irene du Pont in *CHEMICAL AGE*, February, 1920, tells of the trials and tribulations of the du Ponts in war-time chemical manufacture as regards repairs, replacement and obsolescence of chemical equipment. Without the cooperation of the producers of refractory equipment the accomplishments of American chemical manufacturers would be impossible.

Materials differ greatly in their demands upon the container. Iron is without action on only a limited class of chemical compounds or products and while its use unprotected is great it is confined to the confinement of material either intended for industrial purposes, or whose reaction with which is of no consequence. The inter-reaction of iron with bodies by virtue of their acid or alkaline properties whereby color or odor may be imparted or the composition of the contained material affected, requires the coating of the surface by inert material in order that iron or steel may have its general usefulness as equipment in chemical manufacture. And so side by side with the growth of chemical manufacture has developed the production of glass or enameled-lined equipment in its many forms.

In the food industries glass-lined apparatus and tanks are indispensable. In the preparation of every product based on milk—to say nothing of its use in the dairy industry—in the manufacture of soft drinks,

fruit syrups, cocoa and chocolate, in the processing of fruits and vegetables in commercial canning, in the manufacture of drugs and pharmaceuticals, perfumes, cosmetics, essential oils and innumerable products of chemical manufacture, the glass-lined vessel is essential to the production, storage and distribution of commodities whose value is affected deleteriously by contact with iron.

The adhesion of a glaze to a steel plate was a problem which, before its commercial solution, required the prolonged study of ceramic chemists in Europe and America and the expenditure of half a million dollars in experiments. The search for the acid-proof container lead from the unsatisfactory wood-tank to wood vessels with interior coating of compressed paper, to the use of stone, terra cotta, cast iron and plate glass.

James Sargent and C. C. Puffer, business men of Rochester, N. Y., saw the commercial possibilities of a glazed steel tank and persisted in their experiments until success crowned their efforts in the large-scale production by the Pfaudler Co. of light-weight, large-capacity welded steel tanks and numerous varieties of chemical equipment with an interior coating of enamel durable and thoroughly resistant to the materials made or stored therein.



EDWARD J. MINER
President, The Pfaudler Co.,
Director, Chamber of Commerce,
U. S. A.

The relation of chemistry to modern industry is one of the most fascinating chapters in the story of the development of modern knowledge. To my mind the final perception on the part of the average manufacturer of the possibilities of the application of science to the material needs of the world makes a long step forward in the education of mankind. Commerce did not see it clearly at first. It took years of tireless effort, of prophetic crying in the wilderness of industrial ignorance, and no one heeding them; years in which those prophets had to combat not alone the ignorance of those whom they desired to help, but the reproaches of their associates, because they turned from the high road of purely scientific research to the by-paths of sordid commercialism.

Times have changed since the days of our fathers so far as we who are manufacturers are concerned. In their day conditions were static. In the counting house and factory, men followed in the footsteps of those who had gone before, and were guided by the traditions of their business. Now conditions are dynamic. In the industrial struggle in which the world of to-day is engaged only those succeed who are efficient, and that efficiency is based upon scientific knowledge as it is applied to industry.—From Address of Welcome of Mr. Miner at Rochester Chamber of Commerce Spring Meeting, American Chemical Society, April 26, 1921.

Manufacture of the Vessel

According to its use and composition, whether cast iron or steel, the vessel is assembled from flanged or formed plates, or castings, and in the former type joined by welding for which oxy-acetylene and electric methods are used. After the steel tank has taken form all inside joints are carefully ground, and the surface to be enameled thoroughly cleaned by use of the sand blast after which the vessel is ready for application of the enamel. Success of the enameling process depends upon the



Plant of The Pfaudler Co., Rochester, N. Y.

freedom of the surface to be enameled from any foreign matter that will injure the enamel when applied and burned. The sand blast removes all traces of grease, rust, etc., and especially is applicable to large pieces whose manufacture for use in the chemical and allied industries constitutes a distinct branch of the art.

Preparation of Enamel

The raw materials ordinarily used in the making enamels are the following:

Silica:	Antimony Compounds
Sand	Bone Ash
Ground Quartz	Manganese Dioxide
Feldspar	Cobalt Oxide
Borax	Nickel Oxide
Barium Carbonate	Copper Oxide
Cryolite (natural and artificial)	Clay
Zinc Oxide	Tin Oxide
Sodium and Potassium Salts	

Enamels are silicates or borosilicates in which silica, the essential ingredient, is derived from flint, quartz (sand) and feldspar, the nature of the enamel being influenced by the source of the silica. The properties of other ingredients have their respective influence in the determination of fusibility, opacity, color, lustre, toughness, resistance to chemical action, etc.

The preparation of the enamel embraces: (1) the thorough mixing of the ingredients of any particular formula; (2) their fusion until a stable borosilicate glass is formed in which the opacifying agents, fluorides, tin oxide, antimony compounds, etc., are carried in suspension; and (3) the grinding of the cold fused mass with a suitable flocculating agent, usually clay, to an impalpable powder.

The resistance of enamels to chemical reaction with material contained in enameled vessels depends primarily upon the chemical composition of the enamel and the degree to which it approaches a homogeneous glass.

Application of the Enamel

In the application of the enamel it is desired to obtain a uniform coating of sufficient thickness, a process which varies with the size and shape of the surface and the nature of the enamel and includes slushing, draining, spraying or dusting the thing to be enameled, with the enamel in aqueous suspension or as an impalpable powder.

Dusting is used in cast-iron and steel work in the enameling of chemical equipment. This method of application in the production of acid-resistant coatings is of advantage as it does not involve the addition of material that will weaken chemical resistance and which is required in other methods of application.

The thoroughly cleansed and smooth surface is sprayed with water and while wet the enamel contained in a cheese cloth bag is dusted on with a skill that insures an even coating of the powder. The vessel after the coating has "set" is ready for heating.

Fusing the Enamel

The enameling of tanks and chemical equipment obviously requires a furnace of commensurate dimensions. The largest tanks now made are 10 ft. in diameter with calls for greater capacity which will necessitate furnaces still larger than those already the largest known for the purpose. One producer-gas-fired furnace is 17 ft. long, 14 ft. wide and 15 ft. from floor to dome.

The interior coated vessel is transferred by crane without jar to the furnace where in 18-20 minutes the enamel fuses and flows evenly over the red-hot metal surface forming a firm bond therewith. Various other furnaces of shape and size adapted to the production of chemically resistant surfaces of innumerable forms complete the furnace equipment of this remarkable plant.

Personnel and Plants of the Pfaudler Co.

The officers of the company comprise: Edward G. Miner, president; H. W. Dakin and W. D. Phetepiece, vice-presidents; W. G. Markham, chairman, board of directors; Robert Ranlet, treasurer; Clement L. Miner, assistant treasurer; Clifford J. Sothers, secretary; W. H. Middleton, assistant secretary.

Supplementing the service of the Rochester plant, is the plant of the Detroit Safe Works transformed as early as 1888 to the work of the company. The Enameled Metal Product Corp., Ltd., London, England, provides for the English and colonial business. The European continental business is taken care of by a German plant built at Baden in 1907.

Cornell's New Chemistry Building

Authority to advertise for bids for the construction of the \$1,500,000 chemical laboratory was granted at a recent meeting of the board of trustees of Cornell University.

Plans for the chemistry building were waiting the approval of the board some time, the money having been given by an anonymous donor two years ago, shortly after the burning of the old chemical building. The new building will be constructed on the site formerly occupied by the homes of former President J. G. Schurman, Professor C. L. Durham and Professor Ernest Merritt, on East Avenue, Ithaca, N. Y.

The new laboratory will be the best equipped in the world, as well as being one of the largest. Work probably will be begun before the end of the college term and will be completed within a year's time.

Morgan Chemical Corp., E. R. Harriman, president, Ogdensburg, N. Y., will erect an insecticide plant at Atlanta, Ga.



Battery of
Storage Tanks,
Richard
Hudnut, Inc.,
New York



7 Gallon
Per. Jars
for the
Manufacture
of Ginger
Extract,
Alfred Drug
Chemical
Corp.,
New York

Types of Glass-lined Chemical Equipment.

Synthetic Chemical Manufacture

Notes from the Semet-Solvay Co.'s Experience in This Field

CARBOLIC acid or phenol has been our most important synthetic by-product. It is made from pure benzol by the use of strong sulphuric acid, lime, soda ash, caustic soda, carbonic acid gas, a second treatment with sulphuric acid and final purification by distillation. The process involves six or eight distinct chemical reactions and physical steps. Its manufacture is typical of the production of the so-called coal tar products, which are obtained, not from coal tar, but by complex operations that require skillful manipulation and chemically correct conditions. If any one of the many steps be imperfect the yield of the intermediate product at that stage is low or the quality inferior.*

Any chemical compound that requires so few as five synthetic steps gives a final recovery of only 81.53 per cent of the theoretical yield, even though the comparatively high average yield of 96 per cent be secured at each step. It is thus evident that skill and experience are important factors in synthetic chemical manufacture, for many synthetics involve far more than five steps; and a yield of 96 per cent in a step is rarely attainable.

We began manufacture of carbolic acid in 1900 by extracting it from tar oils. But its production from benzol by synthesis is so much superior, when required in large tonnage, that the extraction process was soon given up and synthesis used instead.

Manufacture of picric acid also was begun in 1900. It is made by action of nitric and sulphuric acids on carbolic acid. The result is trinitrophenol commonly called picric acid. About 1903, we began making ammonium picrate by neutralizing picric acid with ammonia. Our manufacture was to meet the military needs of the United States for these two products. The experience gained enabled us to erect a plant at Split Rock in 1915 and to manufacture picric acid in large tonnage to the end of the war.

Salicylic acid was next undertaken, in 1916. It is the basis of one class of dyes and of aspirin and other medicinal preparations. Its production was established and it is now one of our staple products.

In 1912 and 1913, a small experimental plant was started for trinitrotoluol. This process is less complicated than that of picric acid, but it is much more sensitive and difficult to handle. Sufficient work was done to perfect the process, so that in 1915 we were able to build a trinitrotoluol plant and to operate it during the war.

All these operations, except the war plant for explosives, were carried on at Syracuse, on land near the tar plant.

Our war plant was founded upon the experience gained on picric acid, ammonium picrate and trinitrotoluol, between 1900 and 1914. Its location was at Split Rock three miles west of The Solvay Process Co.'s Works. The land was a quarry where The Solvay Process Company had gotten its supply of limestone up to 1910. At that time, most of the better stone had been removed and as the remainder was in thin layers, the quarry was abandoned and the limestone supply obtained from a new quarry at Jamesville, six miles south of Syracuse.

Aspirin was also made during and after the war. It is synthetic resulting from the action of acetic acid upon salicylic acid.

Our most recent work in synthetic by-product manufacture has been by electrochemistry and catalytic oxidation. These methods are radically different from the older, chemical ones. By the action of electricity, or by the presence as catalyzer of mineral or metallic material, like platinum, it is possible to produce a series of chemical compounds from benzol or toluol and to secure them in highest purity with superior yields, and minimum physical losses in process. Our results, supplemented by the experience of The Barrett Company, point to a fruitful and profitable field of synthetic coal tar by-product chemistry. Apparently these simple methods will supplant many complicated, older chemical processes.

This experience shows the wisdom of maintaining adequate financial reserve against amortization of processes and apparatus that become obsolete and pass away through normal growth of scientific knowledge. It also points to the importance of steadily sustained research on a conservative basis, in order that competition may not gain undue advantage by evolution of new, simple processes that supplant earlier ones.

Unless one be in close contact with progress in industrial technique, one has little idea of the great extent to which profitable processes and costly plants may become worthless quickly, through new processes or methods that render old, valuable and seemingly permanent processes and equipment as obsolete as an hourglass in the presence of a Hamilton watch.

Dr. Raymond F. Bacon on Industrial Research in Georgia

At a recent conference of industrial leaders at Macon, Ga., was discussed the project of the establishment at Atlanta of an Industrial Research Station. Dr. Raymond F. Bacon, director of the Mellon Institute of Industrial Research, who was present, said:

"Modern industrial research for a State with the great natural resources of Georgia is an investment of assured possibilities. I use the word 'investment' advisedly, for industrial research is no longer an experiment. Properly conducted, it pays in dollars and cents value.

The natural resources of Georgia are comparable in value to those of the State of Pennsylvania, and in the war Pennsylvania furnished over half of all the great tonnage of war supplies used by our army. The quickest and surest way for Georgia and the South to be able to utilize its great potential wealth is to have a modernly equipped and efficiently staffed industrial research station, where information as to how most profitably to work the natural resources for local conditions can be obtained. The clays, the hides, the ores and the marbles are at hand, but at present, all too often, the Georgian must purchase from the manufacturer in other States his dishes and pottery; his shoes, harness and automobile covers; his bricks and building material; his sculptures—and his tombstone."

The total production of Alsatian potash during 1920 reached 1,061,197 tons, according to statistics received from the office of the commercial attaché, Paris. Of this amount 450,000 tons were sold in France, 327,000 tons were exported to the United States, 117,000 tons to Belgium, and 92,000 tons to the United Kingdom.

Shall I Educate My Boy to Be a Chemist?

A RECENT request, expressed in the letter reproduced below, for information as to advisability of one educating his boy to be a chemist is of such general interest to those touched with the educational propaganda of the importance of the chemical industry to national welfare and the fundamental character of chemistry to all industry, as to encourage us to publish our answer.

Not only is this subject of interest to parents of young men considering chemistry as a career but as well to teachers of chemistry, to employers of chemists and to the chemists themselves.

While we do not expect strict accord from all of these groups with the information and advice given our correspondent, we feel sure of some measure of commendation for our desire to give conscientious consideration to an equally sincere desire for information.

Louisville, Ky.,
April 26, 1921

Editor, CHEMICAL AGE.

I want to take advantage of your offer of service to readers of CHEMICAL AGE to ask you your opinion of my educating my boy to be a chemist.

He graduates from the high school this year and I want to do the best thing by him. The problem is whether to educate him for business or to encourage an interest based on some school experiments to practice chemistry.

I thank you for any suggestions and remain,
Yours very truly,

Chemistry today because of its determinative influence in deciding the war and the education of the people to that fact by patriotic men who demand of government that it shall conserve the chemical industries called into existence by the embargo of war and which supplied the munitions which now are being turned into dyes, have given to the practice of chemistry much of the glamour that 25 years ago was attached to electricity.

While electricity has transformed the world in its infinite applications to heat, light and power production and the means of communication, its industry has been integrated to the degree that the great electrical manufacturing corporations of America can be counted almost on the fingers of one hand.

Chemical manufacture likewise, as has all enterprise, has pursued the same path but not to the same degree, for applied chemistry consists of a process and a product, the tools being available to all. Applied electricity rests on a machine subject to the monopoly control of patent which is the basis of integration in its field. While the opportunities here for clever youth are no less, we wish to show that they are closely controlled.

No branch of study and endeavor is more intimate and embracing than that of chemistry for it includes all that we eat, wear and use for shelter and the maintenance of health and the material refinements of life. In this field, embracing as it does every activity of life, are opportunities infinite and increasing for every shade of aptitude and talent. It is this catholicity of interest and application that demands for success a degree of specialization wherein resides the hazard of individual enterprise whatever may be its character.

It is here that we touch the gist of your inquiry which for obvious reasons no one can answer. If we could, the purpose of life will have been attained and experimentation run its full course in the satisfaction of human curiosity.

For your information and for that of thousands of others touched by the importance and basic character

of chemistry to life and industry and charged with the responsibility of guiding youth, we can submit observations that will temper judgment and that is the best and most anybody can do.

As regards work in chemistry, activity divides itself into three broad groups, viz., the teaching chemist, the production chemist and the business chemist, each intimately related and essential to the progress of the science, art and business of chemistry.

The limit to one's solving problems for another lies in our working him a disservice. From that point the individual must work out his own salvation. Accordingly the best that you can do for your boy lies in providing those facilities along the lines of his ambitions that will present the broadest base for the exercise of judgment.

In the April issue of CHEMICAL AGE one of the ablest men in the packing industry and a large employer of technically educated men declared that there is no calling that does not demand the best education that one can get. The time already is here when not to be educated not only subjects the self-created victim to deserved disgrace, but imposes as a penalty subordinate service throughout life. The exceptions themselves confirm this statement.

Success in its popular acceptance which is fundamentally sound is based upon native and acquired characteristics. Every man differs in the part that each has played in his own experience, but we cannot escape the fact that the boy's native endowment is of profound influence to the degree that it masters and determines the influence of education and the measure of his success in any chosen career.

The most helpful education is that which is self-sought. The best thing that you can do by your boy is to stimulate his worthy ambitions and let his instinctive promptings, his resourcefulness and observation suggest the best means to gratify them. The chip does not fall far from the block; your own scrutiny of ancestral characteristics and the play of desire in the youth's activities are fundamental in the selection of the educational process.

Should this be in the direction of chemistry you will find in the subdivisions of its practice ample field for the ambition and activity of any man.

The Teaching Chemist

If the youth be studiously inclined, of an inquiring disposition and of a mental orderliness indicated by a taste for mathematics; if he possess characteristics which under proper cultivation will turn him into a teacher with aptitude for research; whichever activity to attain the ascendancy will be determined by opportunity and an eye to the main chance.

While we cannot say which of the three general classes of chemists is the most important, it is agreed that the teaching chemist is the most self-sacrificing in his service to a jealous mistress. Where one finds the greatest self-sacrifice, he finds the poorest material rewards, which should be to the eternal reproach of a people that profits most from his activity. His great compensation lies in the satisfaction of his service to others and in the rare enjoyment of cultivating character and seeing it flower into success in which he plays an essential though often an unrecognized part. The superior rewards of industry are always open to the teaching chemist alert to its demands, whose vision,

administrative faculty or ingenuity commend him either to research control, direct production, consulting practice or process work.

The Production Chemist

Production work in chemical manufacture or in chemically controlled industries embraces employment in the laboratory or in the plant. The former is the usual avenue of introduction of the chemist into industry. Here with the enthusiasm of his first job and independence of his parents he is trained in the analytical tests of factory control and gains his initial practical insight into the responsibilities of production.

Largely routine this work soon grows monotonous and irksome. Here the technical novice displays the characteristics that determine promotion. Here come the stirrings of introspection as to whether the lad has picked a winner in his answer to the call of chemistry. Here in the laboratories throughout the country, industrial and governmental, are men beached and mired in the hack-work of chemistry.

If the novice has alertness, a handiness with tools, circumspection of speech, ability to get along with help less favored than himself and capacity to inspire loyalty, i. e., to get work out of them, the production manager early has found this out and his translation to plant work is a logical step in his progress.

To provide men of this type for direct initial employment in the plant, technical schools have instituted courses for the training of chemical engineers. Hereby the young man is trained to familiarity with the larger implements of production by engrafting upon the course in industrial chemistry some of the essentials of mechanical engineering which the progressive chemist has to get by self-instruction or hard-won experience in the plant.

Here in the plant in his contact with help come into play the man's native characteristics which are determinative in his progress in production management.

Industry regardless of its kind is increasingly insistent in its demands for men of managerial capacity. There always is a surplus of men who can do only what they are told, however important those functions may be.

My dear sir, analyze yourself and your wife and the boy's common ancestry and you will have a fair line on what you can expect of him. Giving \$5000 educations to \$500 boys produces many of the tragedies of life and applied chemistry has its share.

Thoughtful men in the wide field of applied chemistry are giving greater care to the selection and study of its trained novitiates, which study should start with and follow his initial steps, which plainly is a responsibility of the teacher who knows on one hand the requirements of industry and on the other the probable reactions of the student. However, there are numerous examples of mistaken judgment.

The Business Chemist

The work of the business chemist while it may not always be the highest expression of managerial capacity, is an avenue of usefulness that makes complete the opportunities of the industry. The man who can sell the goods and thereby keep production active is a dominating character. His close connection with the income and profits of the plant and the educational opportunities incident to the friction and conflict of the competition of the market place give him a grasp of affairs and make the successful salesman the logical leader of the industry. Where the production man attains it, it is because of sales ability.

Personality, character, plays an important part in the movement of goods, compounded of the faculty of making friends and of getting there first with the goods the man wants at a price that the production chemist makes possible.

Here we have the consummation of the effort of the three human elements of the chemical industry. Each essential, the work of each inter-related and interdependent, and all devoted to the service of the consumer which is the people.

Conclusion

Whether to educate your boy for business or to make a chemist out of him is too hard a question for us to answer. We "pass the buck" by trying to help you and the boy answer it yourselves. You know the raw materials. Where we have fallen short is in the lack of emphasis on the aptitude and application required for success.

A New Chemical Meter

In the accompanying illustration is shown a type of new chemical meters developed by Philip E. Edelman, E. E., 39 Cortlandt St., New York, for the use of chemical plant superintendents and foremen for the accurate, direct indication of percentage strength, contamination, etc., of solutions of alkali, acid, salt or of

organic materials.

An interesting application of the chemical meters is in checking up plant operations, thus eliminating need for duplicate, tedious and costly sampling, hand titrations, chemical check tests, etc.

The electrode may be placed in



NEW CHEMICAL METER

directly in the pipe line or vat and left there for continuous readings. The red light shows when there is too much of the reagent, as, e. g., too much acid. The white light shows when the solution or water supply or wash water or tailings as the case may be, is of proper character.

The principle of operation is the Edelman patented compensated electrode method which automatically provides and self-corrects for varying temperature, bubbles, etc. In its operation, as e. g., in autoclave work, a well-known chemical engineer stated, "Why, it's just like looking into the autoclave."

The Cellulose Silk Co. of America will shortly begin operations at Chester, Pa., using an improved copper-ammonium process for the manufacture of artificial silk.

* * *

To interest consumers in dehydrated products the Department of Agriculture sent 3,000 quarter-pound packages of dehydrated vegetable soup mixture to as many hotels. Many recipients declared the product not only cheaper, but equal to the fresh article in many respects, and almost without exception spoke in approval. One pound of the mixture makes 125 portions. The work of the Department in overcoming prejudice will be contemporaneous with the establishment of the industry on a commercial basis.

Portland Cement Manufacture by South Dakota

Report of the State Cement Commission of South Dakota on the Project to Erect and Operate a State-Owned Portland Cement Plant.

THE South Dakota Cement Commission comprises Peter Norbeck, Governor, chairman ex-officio; Frank H. Barnard, secretary-treasurer, and Paul E. Bellamy, W. J. Sherwood and C. M. Harrison, and has authority to issue bonds to the amount of \$2,000,000 to procure funds to complete the project. Active steps in the construction of a plant of 2,000 bbls. daily capacity, at Rapid City, South Dakota, are delayed by present conditions in the machinery market. At this site are available, without stripping, crystalline limestone and a satisfactory shale, the former capable of delivery by gravity to crushers.

The report of the Commission embraces a discussion of Portland Cement manufacture and reveals not only an interesting local economic situation but provides a commentary on the place of Portland Cement in the progress of the country.

Portland cement manufacture embraces five processes: assembly of raw materials at the crusher; reductions to powder; production of clinker; grinding the clinker; and packing.

Assembly of Raw Materials

Portland cement is made from a suitable combination of calcareous material (chalk or limestone) and argillaceous material (clay or shale). It was found after considering the production costs and the quality of cement obtained that a mixture of $3\frac{1}{2}$ parts of Minnekata limestone to 1 part of pierre shale, available at the Rapid City site, was the proper proportion.

The limestone in the quarry is loosened by explosives, loaded in cars by steam shovel and conveyed to the mill by locomotive, mule, cable or other suitable power and dumped directly into the crusher.

Crushers are usually large enough to take blocks of limestone up to 2-3 ft. across. After one or two reductions in the crusher, it passes to a storage bin in sizes that will pass through a 2 or 3-in. ring.

The shale or clay is handled by a steam shovel and cars and is crushed and delivered to storage bins in a manner similar to the limestone. From the storage bins the limestone and shale are drawn in such quantities to make a properly proportioned mixture, to be delivered to grinding machines of various types in which it is ground to a fine condition.

Up to this point in the manufacturing, the procedure is the same in both the wet and dry processes. In fact, there is, no difference between the wet and dry processes, except in the grinding and first stage of burning. In the wet process plant the limestone and shale are drawn from the storage bins in the proper amounts to make the correctly proportioned mixture, and is fed into grinders of various types with a sufficient quantity of water to make a thin mud after the same is ground.

In the dry process plant, the proper amount of limestone and shale is drawn from the storage bins and passed through cylindrical dryers which expels all but 0.5 per cent or less of moisture. From these dryers it is conveyed to the grinding machines, which reduce it to a fine powder. In order to make it essential that this grinding be done sufficiently fine, the general requirements are that at least 95 per cent of it should pass

through a screen with 100 meshes each way to the square inch.

After being sampled and analyzed by the chemist, who corrects the proportions of clay and limestone if necessary, it is fed directly into the kilns. In the wet process, the thin mud, which is called "slurry," is handled by pumps.

Production of Clinker -

The modern rotary kiln consists of a steel cylinder from 8 to 10 ft. in diameter and 125 to 240 ft. long, lined with fire brick and suspended on bearings so arranged that it can be revolved by power. It is set at an inclination of about $\frac{3}{4}$ in. above the horizontal to 1 yard in length. The finely pulverized raw material is introduced at the upper end, while the fuel for burning is blown in at the lower end. Gas, oil and coal are used for burning. Any plant which would be built in this State, however, on account of the cost, necessarily would use coal.

The coal is ground to a fine powder, and when blown into the furnace in this condition with the proper combination with air, burns similarly to oil or gas. In order to grind it to the proper fineness, it is necessary to dry the coal so that it does not contain more than 0.5 per cent of moisture. Most of the commercial coals from Iowa and Illinois contain from 6-13 per cent of moisture as mined. Wyoming lignite or semi-bituminous coal contains 20 per cent of moisture, while the South Dakota lignite contains from 30-40 per cent. This finely ground coal is quite explosive and must be handled carefully with special equipment.

The temperature required in the kilns varies from 2,200-3,000° F. and is easily controlled by the burner in charge. As the kiln is revolved the raw material mixture (because the kiln is inclined) gradually works down from the upper end—which, of course, is the coolest part of the kiln—to the lower end, where the cintering takes place. It leaves the kilns as a red-hot clinker and goes into a revolving cooler, from which it is conveyed to the clinker stock pile.

Grinding the Clinker to a Powder

While the clinker contains all the chemical properties of finished Portland cement, it has no setting qualities until it is finely ground. Fine grinding of the clinkers is essential to the manufacture of good cement. Government specifications require that 80 per cent. of the ground cement should pass through a screen with 200 meshes each way per sq. in., which means 40,000 holes per sq. in., each opening being 0.0029 in. Many authorities are of the opinion that any part of the clinker which is not ground this fine is an adulterant.

The mills used for grinding the clinker are of various types, many of them being similar to the grinders for the raw material heretofore referred to. The process is the same except that the grinding is always done dry. During the grinding process a small amount of gypsum is added in order to control the rate of setting.

Packing

Freshly ground cement will not set satisfactorily and as such is known to the trade as "hot" cement. It is necessary to let it age for four weeks or more. In

the more densely populated sections of the country a large amount of cement is shipped in the bulk—carload lots—to contractors who have special facilities for handling it in this condition. The high price of sacks is quite an incentive to this method of shipment. Both canvas and paper sacks are used.

Packing cement in sacks is the hardest and dirtiest work around a cement plant. This is usually done with automatic machinery. It is about the only work around the cement plant for which payment can be made on the piece basis, which is generally the rule.

Work of the State Cement Commission

The State Cement Commission was organized in August, 1919. Considerable preliminary work had been done by the governor and state engineers, so that the Commission immediately started consideration of the problems before them.

The general impression at the time the Commission was organized was:

That there were a number of places in the state where raw material suitable for manufacturing a good grade of Portland cement could be obtained.

That the plant of the Western Portland Cement Co., at Yankton, had been operating successfully for a number of years until it had been bought by the so-called trust and closed down.

That at Chamberlain the erection of a plant by the Dakota Portland Cement Co. had been started. Considerable work had been done, some machinery had been bought, but activities had been suspended owing to lack of funds.

It was known that the State School of Mines at Rapid City had investigated the cement possibilities of the Black Hills and found them favorable; in fact, had actually made cement experimentally from some of the raw material.

It was also realized that a shortage of cement was impending.

By virtue of authority conferred by statute the Commission began an investigation of the cement resources of the state. This was found to be particularly difficult because there had been no general systematic geological survey of the resources of the state. While much geological work had been done, it related principally to the water resources of the state and the minerals of the Black Hills. Furthermore, some items of the information published were misleading.

We have made a geological survey of the cement resources of the state. In some localities drilling has been resorted to to determine the extent of the deposit and to obtain samples for analyses to determine the quality. In other localities where the drilling was not deemed necessary samples for analysis were taken directly from the exposed faces.

Some 300 analyses of the cement raw material have been made and compiled together with all previous analyses on record which appear to have any bearing on the investigation.

Our investigations have also included a survey of the various coal and oil fields available for fuel in South Dakota, with their heating value, chemical composition, etc. Due consideration has been given to freight rates on fuel.

In so far as it is possible, through questionnaires to dealers, consumers and others, inquiries have been conducted in regard to the probable future consumption of cement.

Investigations in regard to the prices for cement charged in the various parts of the state by present manufacturers have been conducted.

Our investigation included a census of the cement consumption of the counties and, in total, for the state for the year 1919. The consumption of cement per capita for the state has been calculated.

We have investigated the comparative cost of building and operating plants of various capacities from 1,000 to 3,000 bbls. per day.

Preliminary detailed plans of the estimate of cost of equipment, of cost of buildings and estimate of daily cost of operating a plant of 2,000 bbls. per day capacity have been made for the six most promising localities in the state.

We have ascertained the cement freight rates from the various prospective sites in the state and calculated and tabulated the same from each site to each county in the state with totals in proportion to the estimated consumption of cement therein, thus obtaining the average freight rate per barrel to each county in proportion to its anticipated consumption. The same calculations and tabulations have been performed from present factories which are now supplying most of the cement trade in the state. Rate-making bodies and traffic officials of the principal railroads of the state have been consulted with a view to probable reductions and adjustments of the cement rates.

We have manufactured cement experimentally from various locations in the state to determine the actual relative cost of manufacture and have tested this cement to determine its relative quality.

We have had the advice and consultation of the best engineers available and have had the information thus obtained checked and confirmed.

Through consultation and correspondence with the various states in the Union we have found that practically all of them have experienced detrimental shortages of cement due to increased consumption.

By virtue of authority conferred by statute we have contracted for the purchase of a cement plant site near Rapid City which contains sufficient raw material of excellent quality.

This site also includes sufficient land for a future town and has municipal water rights, sewage disposal facilities and fertile soil for home gardens. It is adjacent to the plant and available for employees' homes.

Summary of the Commission's Report

We have found the best cement materials in the Black Hills, and that a first-class grade of cement can be made from the same.

We found the chalk rock along the Missouri was of an inferior quality, and undoubtedly the Yankton and Chamberlain plants were abandoned on that account.

That in the vicinity of Mitchell we found the chalk rock heavily overburdened and of an inferior quality.

That, owing to cheaper fuel, water power now available, cheap quarry operation and other factors, cement can be manufactured at our site near Rapid City and delivered to the consumers in the state much cheaper than from any other point.

That with the sale of part of the bonds from the \$1,000,000 authorized by the former legislature the Commission will proceed to pay for the site and prepare plans for a new, well-equipped cement plant, in which the Commission is convinced they can manufacture a cement which will be equal to the best at a maximum price of \$1.36 per bbl., on the basis of the August, 1920, prices; but that they cannot complete an efficient, economical plant from the proceeds of \$1,000,000 of bonds already authorized.

That our estimates show such a plant on the basis

of August, 1920, figures will cost in the neighborhood of \$2,000,000, including a reasonable working capital; but since that date there has been some decrease in the price of cement machinery and building costs, which, we hope, will further decrease before we are ready to place orders for the same.

That the Commission is unanimously of the opinion, after a thorough investigation of the cement situation in the United States, that there are not enough plants now in operation by 50% to furnish the cement that will be needed for building operations, street and road construction to supply the demand for the next five years.

That there are no cement plants now in operation within 175 miles of the state of South Dakota. There are none in North Dakota, eastern Montana, northern Nebraska or western Minnesota. In fact, there is no good cement material within 500 miles east of the Black Hills.

That with the prospective demand and use for cement in South Dakota within the next five years, we are of the opinion that a cement plant located at Rapid City would save the people of the state twice the cost of building the plant.

That out of the appropriation of \$25,000 for this investigation your Commission have expended to date the sum of \$12,658.11.

That the building work of the state has been retarded in brick and concrete, and has also been retarded in lumber on account of the inability to get cement for foundation purposes.

That, owing to the large amount of capital required, present manufacturers are the only capitalists who would be likely to build a plant in this state. Owing to the fact that they are now supplying all the cement used in the state it would not be much to their advantage to build a new plant within the state.

That the Commission has information which leads it to believe that one of the largest companies which ships cement into the state and from which we bought more than one-half of our cement in the four years from 1916 to 1919, inclusive, has declared 146% dividends on the common stock during that time.

That the amount of cement shipped into the state in the year 1919 was 741,495 bbls., or 1 1-16 bbls. per capita.

That this was an increase in consumption per capita of almost double since 1914.

That, in the opinion of the Commission, the rate of consumption per capita will continue to increase in the future, and particularly so if the cost of the cement to the consumer is lowered to any great extent.

That cement is a superior building material for South Dakota and that as soon as the available supply and a more reasonable price permit its advantages to be more generally known its use as a building material will, to a considerable extent, supplant lumber. Up to date five-sixths of the forests of the United States have been used.

That the present price to the consumer in this state is from \$3 to \$5 per bbl.

That there has been some reduction in the price of cement plant construction material and that further reduction can be expected by the time the Commission is ready to purchase the same.

That there would be a ready market for the entire output of the plant within the state.

That in case there is a surplus a ready market will be available in the adjoining states.

That freight rates on cement are discriminatingly high for this state, but the Commission is assured

that it will be possible to get a material reduction in the same as soon as they have cement ready to move from a factory within the state.

That at Rapid City the price of coal and the quality of the same with freight rate considered are more advantageous than the price of coal at the plants which are now supplying most of the cement consumed in this state.

That it will take from a year to a year and a half to build a suitable cement plant.

The State Highway Commission informs us that approximately one-half of the output of a 2,000-bbl. per day plant will be used from now on on the highways of the state, for bridges and other structures, and that in addition to this, if paved roads are built, they will consume nearly two days' capacity of the plant per mile of road.

That a 2,000-bbl. per day plant would supply about two-thirds of the demands of the state by the time it is completed and is the most economical size to build.

That a plant of this size could be built and equipped, including site and operating capital, for about \$2,000,000 under the August, 1920, prices of materials and machinery.

That from the most reliable information the Commission has been able to obtain the wholesale price of cement to dealers from present manufacturers on November 1, 1919, delivered all over the state in proportion of 1 bbl. per capita of population, which was \$3.53 per bbl., without sacks.

That under efficient management a first-class grade of cement could be manufactured in a state plant and delivered all over the state in proportion of 1 bbl. per capita of population at \$2.38 per bbl., f. o. b. destination. This estimate is based on figures compiled in August, 1920. Subsequent reductions in material and labor costs would show a substantial reduction from this price.

That this cost delivered figure of \$2.38 per bbl. includes a depreciation charge sufficient to maintain the plant perpetually in operating condition and a sinking fund charge sufficient to wipe out the investment in twenty years and an interest charge on the investment at 6% until such investment is liquidated.

That, if the prices of material and labor go down to any great extent in the future, the cost of cement manufactured in such state cement plant will go down in proportion.

That a state cement plant would have a stabilizing effect upon the price of cement to the consumer.

That with equally efficient management the state would be able to manufacture cement about 10% cheaper than private companies. The state would have no local or income taxes to pay and the sales expense would be very low because they would sell largely to the State Highway Department and counties.

The protest of the National Aluminum Founders' Association and the National Automobile Chamber of Commerce before the Ways and Means Committee against an increase of the import tax on aluminum from 2 to 7 cents per pound was based on representations that the Aluminum Co. of America thereby would have absolute control of aluminum production in this country. The Federal Trade Commission has decreed that the Aluminum Co. of America shall divest itself within one year of control of the Aluminum Rolling Mill Co. of Cleveland which it had acquired from the Cleveland Metal Products Co., as such control "tended to and did create a monopoly" in sheet aluminum.

CHEMICAL AGE

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A Consolidation of
The Chemical Engineer
and Chemical Age



GERMAN submission and promise to initiate reparation payments under the Treaty of Versailles mark an important forward step in the readjustment of international relations. Admission of responsibility and capacity to atone has its direct reflection in an optimism on which improvement in domestic affairs may be based.

American economics is as inextricably bound up by nature with that of the world as was by artifice the League of Nations with the Treaty of Peace, which fusion, in the dream to make the world safe for democracy, made it unsafe for anything else. Now in the recovery from the delirium of economic derangement the forces of reversion are in eclipse, with growing recognition of the eternal law that progress is only through discipline and that the exercise of power without the earned right to possess it, carries its inevitable dethronement.

Power can be justified only by the intelligence with which it is exercised. Authority in industry that looks not beyond class aggrandizement finds its fate in the condemnation of the common mass that will not stand indefinitely the penalty of its support.

One by one the great groups of labor are submitting to the deflation which must come before American industry can resume its place in the service of the people. Persisting inequalities of adjustment are a part of the pains of progress and must be borne until extinguished in the general level of equality in the purchasing power of every man's dollar.

THE defects of human nature—selfishness, ignorance—make the process slow; which fact is a commentary upon the responsibilities of the educated in a democracy whose progressive government resides in the wise control by the aristocracy of service that has its roots in organized industry.

The human element in production resists in its nominal wage that deflation that has run its course in

raw materials whose value is set in the world markets, in the face of economic law that already has deflated the real wage by the creation of unemployment estimated in millions.

Resistance to price and wage revision by entrenched groups is self-deception in the hope that in the turn of the tide the same may be unnecessary, meantime compelling other industries to absorb their higher costs in continued exactions of the public, with the latter's revolt at the levy of tribute.

The return of labor to employment and the revival of purchasing capacity essential to the restoration of production and trade, are possible only by the widespread leveling of values of effort and of product.

Recalcitrancy to this fundamental requisite to the return of prosperity works only to the disadvantage and distress of all and delays the resumption of a service to needs unexampled in the history of our country.

THE perplexities of present conditions are increased by our inescapable responsibilities in the economic readjustment of the world. Thanks to sound judgment these do not embrace political entanglements!

The performance of German promises of reparation payments connotes a level of production costs that we as a manufacturing and exporting nation can meet only by that maximum utilization of our own production capacity which implies the highest beneficence to our own people in prices that encourage consumption and employment. On the other hand as the arch-creditor and greatest producer of raw materials, we can exact payment to our advantage only in kind, which means consumption of foreign products with consequent restriction of domestic production in certain lines.

Making room for everybody in a world that is big enough for all, demands that stimulation of consumption everywhere which is limited only by capacity to pay.

THE position of America in the era upon which we are entering will be determined by American labor and American technical men.

With the diffusion of education and the encouragement of wise leadership we may expect a reversal of the state of the mind intent not upon how much can be done in a given time but how much can be got for a nominal service, and a recognition of the fact that labor's wage is derived solely from and is a part only of the product, albeit a large one. Any other thought is fundamentally fallacious, immoral and destructive of all confidence and cooperation.

Industry blesses the world and makes possible the real gains of society by improved methods of production. The individual benefits by the creation of more to divide and not by alignment in groups to levy tribute on his defenceless fellows.

Strife never will cease because it is an instrument of growth, but it can be ameliorated to check the by-products of waste in industry and of hostility to the common welfare.

APPLIED science and the mind trained to industry are the sheet anchors of society for they make possible the plenty and perfections of life.

The press of population upon raw materials, compelling by its increase an ever closer and more effective organization for production and distribution, and by the necessity of cheaper goods, the discovery and use of new materials and new processes, has given to the technically trained man whether he be chemist, engineer, or chemical engineer, a prominence deserved in an industrial civilization whose keynote is efficiency.

Despite all its refinements, the appalling wastes of modern industry, whose appreciation itself is an index of education and whose burden is borne by the consumer, disclose a wide avenue to lower production costs by their progressive elimination. Research now is recognized as a potent instrument whereby not only may the savings of science be passed on to the consumer, but that industry itself may be kept abreast of the latest developments and so buttressed in the strife of competition.

In these activities the technical man dominates. His slogan is service. He prospers only as he helps and in his benefactions to mankind he is the material savior of the world.

CAPITAL is the child of thrift and the parent of progress, in which simple genealogy is seen the play of individual efficiency which alone makes nations great.

Thrift is to economics what the maternal instinct is to biology. The one projects the race into the future; the other endows it with the capacity of the stored-up labor of the past.

How blind are men, how important the role of education, how essential the recognition of the Golden Rule, to peace and plenty!

ALCOHOL is not only an important raw material of chemical manufacture but is itself a chemical product whose use, limited only by its cost, should not be subjected to restrictions that will interfere with its increased production and industrial consumption. Cheaper alcohol means lower prices for the innumerable products of general use in whose manufacture it is essential.

Because of a leak between the distillery or bonded warehouse and the chemical plant, prohibition agencies wish not only to tax the tax-free denatured article, but, by increasing the list of materials by many hundreds for articles to which alcohol is essential, as drugs, flavoring extracts, perfumes, etc., to subject legitimate users to such hindrance and annoyance as to be detrimental to the industries involved.

Bonding transportation agencies in whose hands the leaks occur would aid in prohibition enforcement without forcing upon chemical manufacture the contumely of bootlegging by annoying interference with legitimate industry.

LAST October, before judgment had been rendered, CHEMICAL AGE asserted that in the next four years technical men as advisors and administrators in national affairs will be accorded a recognition never dreamt of before.

The executive ability and experience of Herbert Hoover made him the logical cabinet representative of this element of industrial leadership. In his position as Secretary of Commerce he has brought into action that analytical scrutiny and constructive capacity that have made American industry pre-eminent, with the result that not only is an important governmental department assuming an efficiency as a public servant never before practised, but precedents are being established that in due course will have their influence in all branches of political administration.

Industry can look to this technical man as a presidential advisor to conserve those interests and to advance those measures that mean most to the common welfare in whose progress all endeavor has its sanction.

OUR government is one pledged to equality of opportunity in the support of which it always has been alert to impose restrictions upon the growth of economic groups whereby a few could dominate the many. In the development of our natural resources we have welcomed the enterprise of the world and in the development of backward regions everywhere we have demanded on foreign soil what we freely have granted on our own, viz., the open door.

There is abroad in the world such departure from this basic principle of sound intra-national and international relations as to compel the direction of attention to practices that carry the seed of discord and of strife comparable to that the world has just passed through.

Not only are various nations restricting the development of natural resources within their own boundaries to their own citizens but their governments are lending their influence and support to secure for their nationals in countries foreign to them exclusive concessions over raw materials and the facilities of trade. We see abroad government participation by encouragement in the creation of economic groups whose activities can dominate the efforts of individual merchants of other nationalities, while we condemn and prevent similar activities in domestic production and distribution. We see abroad combinations of exporters and importers designed to dominate certain trades in the purchase of materials and the sale of products, with power to dictate prices and thus industrial conditions in foreign countries.

This tendency to militant exploitation and domination of the commercial world easily may become a menace to peace and demands the consideration of statesmen and industrialists. Such procedure not only is foreign to American tradition, practice and ideals and if persisted in only can result in the necessity of its practice here, but plainly is violative of the true principle of all relations, viz., equal rights for all and special privilege for none.

Chemistry and Craft in Scientific Instrument Manufacture

The Bausch and Lomb Optical Co.

Commendation of American Enterprise in the Establishment of a Domestic Optical Glass Industry

THE progress of science in America and its application to industry, to say nothing of the dependence of optics as it is popularly understood, are an intimate reflection of the enterprise and thrift of a humble German emigré who in 1853 established himself as a spectacle maker in Rochester.

Today in his 91st year is vouchsafed to this man the supreme satisfaction of a service permitted to but few to render.

Bred to the craft of a lense-grinder his arrival in America as a youth of 19 found him no work at his trade, and he became a wood-turner. The loss of two fingers of his right hand compelled him to turn to his original craft in the practice of which in the primitive conditions of the time he laid the foundations of the art and business of optics in America.

His work and that of his organization progressively has been to make his country independent of foreign sources of supply until, in the emergency of war, complete independence was attained by the manufacture of optical glass heretofore imported entirely from Europe.

The war requirements of the Government for instruments of precision of every class involving the use of optical glass placed upon this organization a responsibility, successful response to which has made it the largest, most self-contained institution of its kind in the world and has brought to the organization of John Jacob Bausch and Henry Lomb, who in the early days of privation founded the house of Bausch & Lomb, the gratitude of America.

The service of an optical instrument, whether the common spectacles, the microscope or any device whose utility is based upon the use of light, is determined by the quality of the lense. The manufacture of the glass from which the lense is ground is essentially chemical; the manufacture of the instrument and accessories is mechanical.

From this combination is created the optical instrument in its multitudinous forms ranging from the eyeglass for defective vision and professional equipment for its study and practice, to range finders, gun



JOHN JACOB BAUSCH

Mr. Bausch was born in Suesen, Württemberg, Germany, July 25, 1830. In good health and spirits, he is a daily plant visitor and observer of the administration of the business of the Bausch & Lomb Optical Co. In the retrospective comment of his 90th birthday, Mr. Bausch said: "Three things stand out in my mind: First, the greatness and grandeur of America; second, the power of thrift; and, third, the rewards of perseverance. America—to give opportunity! Thrift—to save for future need! Perseverance—to stay in the game until luck (or whatever you want to call it) changes!"

sights, periscopes, searchlights, opera glasses, binoculars, astronomical and engineering instruments, microscopes, projection and photographic apparatus, and scientific instruments for use in every department of pure and applied science. Optical glass differs radically from other varieties both in its properties and methods of production due to the fact that optical glass as a mechanical raw material is required in chunks which are broken into fragments, those showing defects being discarded while the apparently good pieces are progressively worked into a shape approaching the finished lense.

All older optical glasses usually designated now as "ordinary" crown and flint glasses, are of the nature of pure silicates. The basic constituents of crown glass are silicates of lime and soda or lime and potash or both; those of flint glass are silicates of lead and soda or lead and potash or both.

The newer optical glasses are characterized by a much wider variety of chemical constituents, being the oxides of barium, magnesium, aluminum and zinc. Those bases are used either with or without the bases characteristic of the older glasses.

The distinguishing properties of optical glass are (1) transparency and freedom from color, (2) homogeneity, (3) hardness and chemical stability, (4) absence of internal strain and (5) refraction and dispersion.

To supply the loss of European importations of optical glass in 1914 upon which the American industry was dependent, early experiments of William Bausch were renewed with such zeal and cooperation that when the United States entered the war in April, 1917, the government found the Bausch & Lomb Optical Co. the only one producing a satisfactory glass.

With the experience acquired in the satisfaction of the extraordinary needs of war, lenses equal to and surpassing those formerly made from imported glass became a regular product. The optical glass plant underwent progressing enlargement, employing when at full capacity 500 hands and using



WILLIAM BAUSCH

Secretary, Bausch & Lomb Optical Co., Creator of American Independence in Optical Glass Manufacture.



MARTIN H. EISENHART

'07 Chemical Engineer, Mass. Institute of Technology, Production Manager, Bausch & Lomb Optical Co. Representative of the Third Generation in Its Business Administration.

33 million cu. ft. of gas per month which is equivalent to the monthly consumption of a city of 60,000 people.

The provision of suitable clay pots for melting the glass at the tremendous temperature required was a difficulty that surpassed the capacity of American potters and demanded further technical research whose outcome was the construction of a pottery adjacent to the glass plant, wherein, under the direction of a ceramic expert, were produced glass pots of a quality superior to any that could be obtained in the American market.

The optical glass plant contains besides 6 single-pot arches, 18 double-pot arches and 1 stove arch, 5 single-pot, 3 double-pot and one 16-pot melting furnaces, with a total capacity of about 416 pots per month.

The most distinctive advance in optical glass manufacture dates from 1876, when Professor Abbe, of Jena, Germany, declared that future improvement of the microscope was in the hands of the glass-maker, meaning that the optician had attained the limit of development in precision optics with the glass then available. The next five years witnessed the production of a whole series of new glasses, novel in composition and optical properties, by Professor Abbe and Dr. Schott, collaborating as Schott & Genossen at Jena.

Great care must be exercised to assure chemical purity in the raw materials of optical glass. Not only must the infusible and color-producing impurities of ordinary glass be avoided, but, as well, the admixture of glass-forming bodies other than those needed as they might modify the optical constants of the glass. Uniform composition and thorough admixture in



DR. HERMANN KELLNER
Chief Scientific Bureau, Bausch & Lomb
Optical Co.

Constantly investigating and experimenting, this Bureau invents, develops and further improves the products to meet the ever changing demands. Dr. Kellner, since 1905 a member of the B. & L. organization, studied at the Universities of Jena and Berlin and served for years on the Zeiss research staff. He is a pioneer in successfully correlating theory and practice in the manufacture of optical instruments in America.

unvarying proportions are essential. Addition of the mixture to the pot is preceded by its preliminary heating for 4-5 days in the pot-arch or subsidiary furnace. At a temperature of 1800° F. it is transferred to the melting furnace, heated meanwhile to the same temperature, which is now raised to 2400-2600° F., according to the melting point of the type of glass to be made. The mixture is now added to the pot at intervals and fused until filled with the glycerine-like mass of molten glass.

To render the molten glass homogeneous stirring is highly important to overcome the formation of striae due to the different specific gravities of the ingredients of the mixture, and to bring all the materials into solution. This is effected by means of a mechanically operated clay rod on the end of a water-cooled tube. With continued stirring the temperature is allowed to fall until the glass becomes stiff, requiring from 8-20 hours, according to the type of glass. Optical pyrometers are used to determine the temperature progress of the melting process.

On completion of the melt the pot of glass is transferred to a cooling furnace, where, in addition to the 24-48 hours required for melting and stirring, 5-6 days are required for cooling.

The pot and contents are now broken up and selected fragments are moulded in small pressing furnaces into forms, which in turn are examined for striae. Subsequent moulding, inspection and cutting to the size and weight desired precede grinding into lenses and their final mounting into the various forms of optical instruments.



Plant of Bausch & Lomb Optical Co., Rochester, N. Y. Optical Glass Plant in Background on Grosvenor River Flats.

The American Institute of Chemistry

Additional Observations on the Project of an Economic Organization of Chemists

THE growth of the New Jersey Chemical Society, which functions in the state of New Jersey as the first state organization of the American Institute of Chemistry, to a membership of 704 with early expectations of attaining 1000 and the establishment throughout the state of branches, is an augury of what may be expected of the extension of its activities to other states in the progress of the development of a national organization.

A constitution is now in process for early promulgation under which chemically educated men who make their living in the chemical and allied industries may organize for later coalescence into an integral body.

Conditions were never more propitious, and will become increasingly so, for the formation of an economic organization of educated workers in the chemical and allied industries.

This movement in other states will duplicate its success in New Jersey because it has a heart and satisfies a manifest need of the individual and the industry. Alert chemists who appreciate this fact will initiate organization in their respective sections and thus lay the foundation of a work which has its precedent and guide in the American Association of Engineers.

The American Association of Engineers is the answer of young professional engineers to the class-control propaganda of unionism and reflects their aspirations to recognition in a large measure denied them by the early professional organizations in their respective fields.

Youth must be served; and the ambitions rooted in unutilized potentialities must be guided in directions productive of the maximum advantage to the industry and to himself, for it is only in the former that he can work out his salvation. Pulsing sinews demand exercise and the trained mind that controls them revolts at autocracy that would dominate the intellectual enterprise of his profession.

The American Association of Engineers, with a membership of 25,000 that makes it the largest single technical professional body in the world, was founded to promote the economic and social welfare of engineers. In its existence of six years it has a record of accomplishments that puts in the shade the work of any comparable organization.

In this organization, in the English organization of the Institute of Chemistry of Great Britain and in the stimuli of the American environment, are precedents ample for duplicating among chemically trained men the unparalleled success among professional engineers of the American Association of Engineers.

With its membership campaign fought to a success, the Association cited now can concentrate upon its own constructive service and the education, support and correlation of its chapter activities. An economic organization of American chemically educated men to succeed must be worked out along the lines of its experience.

The virility of the American Institute of Chemistry likewise will lie in its service to the individual; in its aid from classroom and university laboratory to the work of production and distribution of goods, to make him fit more efficiently a more useful place in the responsibilities of his field.

An economic organization of chemically trained men

based on such principles is assured of general commendation because its need is recognized. Withholding of good-will because two horses cannot be ridden at the same time is of little consequence to men determined to help their kind in a way that will make them help themselves.

The more the thoughtful man reviews his own experience and considers the experimentation, time and money cost involved in the preparation of the technical recruits of industry, the more he is convinced of the need of the American Institute of Chemistry for the educated chemical workers of America.

Ill-judgment and the opportunities of mistake are too great and the penalties too severe in this day of efficiency in the handling of trained man-power, to warrant further neglect in the organized study and placement of men educated to work in the fundamentals of industry.

Legitimate aspirations ignored only reinforce the determination of their realization. A manifest need strictly in line with human growth, that is denied satisfaction by indifference or condemnation in its many forms, gathers the inevitable strength that will compel recognition.

Destiny demands an independent organization with well-defined, minimum purposes with whose accomplishment and the prestige of success will come adsorption of others, all having to do with the service of the chemical industries and of its triple essentials, viz., the teaching chemist, the production chemist and the business chemist.

Wisdom teaches that a natural process should be encouraged and controlled. Its beneficence cannot be worked out in an organization aloof to its promptings and callous to its call.

The U. S. Food Products Corp. has resumed, after an idleness of several months, the operation of its largest alcohol plant, located at New Orleans, La.

* * *

A recent acquisition of the Union Carbide & Carbon Corp. is the Clendennin Gasoline Co., Charleston, W. Va., the reported price being \$500,000. The latest subsidiary company of the former organization is the Carbide & Carbon Chemical Corp. which will use the products and by-products of the various controlled companies in allied chemical manufacture.

* * *

The Tennessee Copper & Chemical Corp. in 1920 converted an operating loss of \$234,416 in 1919 into an operating profit of \$162,650. The production of sulphuric acid for 1920 amounted to 333,629 tons of 60 deg. acid, as compared with 266,627 tons in 1919; copper, 10,358,237 lbs. from company ore, as compared with 10,414,815 lbs. in 1919. The corporation also produced 58,586 oz. of silver and 237 oz. of gold.

The Atlanta, Ga., acid phosphate plant of the subsidiary, the Southern Agricultural Chemical Corp., was placed in operation in Nov., 1920, and has been operating steadily and satisfactorily since that time.

The ten-year sulphuric acid contract with the International Agricultural Corp. expired on Dec. 31, 1920. New contracts at a much higher price have been entered into with this and several other large fertilizer companies for their requirements of acid for three years from Jan. 1, 1921.

American Graphite

An Appeal for the Preservation of the Domestic Industry

By A. B. Conklin

President, Clay County Graphite Co., Ashland, Alabama.

THIS seems a proper time to discuss in a technical journal like *CHEMICAL AGE* the advantage or disadvantage accruing to our country by maintaining an economic independence of the world, and particularly in articles essential in war.

The opening of hostilities in the European war substantially increased the use of graphite. The shortage of ocean tonnage at the time soon developed an acute shortage of graphite in the United States. The final submarine policy of Germany practically paralyzed all Oriental trade from those regions on which the United States at the time depended for its graphite supplies. It was known that we had deposits of graphite, but they never had been developed. The lack of our development in this resource was soon appreciated, and the Government war boards immediately directed their attention to the problem of making this latent supply available. The crucible-makers besieged the domestic graphite fields begging for graphite, and in their visits to the Alabama field urged greater expansion of

tion, predicting dire results should the consumers call for more than the limited percentage they were required to use of the domestic product.

The Mineral Relief Act, passed by Congress and signed by the President in October, 1918, carried the promised protective feature, but through the President's failure to name an administrator for the bill before the armistice was signed this protection was lost to all war minerals, including graphite. This industry, which was built up exclusively with private capital, but with the Government's assurance that it would be protected, found itself, on the signing of the armistice, in direct competition with 60,000 tons of accumulated graphite waiting shipment from Ceylon and Madagascar. This amount was sufficient to meet the crucible requirements of the United States for three or four years. It was produced by labor which is paid about one-tenth the rate of our wage scale.

The result of this condition easily can be appreciated. Mills immediately were shut down, thousands



Close-up view of mine of Superior Flake Graphite Co., Clay County, Alabama. Alabama graphite is mined from open cuts, the ore running from 1 1/2 per cent carbon, averaging 2-2 1/2 per cent carbon. Crucible grade of refined graphite must contain not less than 85 per cent and lubricating grades a much higher carbon content.



View of mine and buildings of Superior Flake Graphite Co., Clay County, Alabama. J. C. Sturges, our, manager. One of numerous plants in the Alabama graphite field in the development of which the Government encouraged the investment of \$4,000,000 in the application of the most improved methods, with assurance of support on the cessation of hostilities.

graphite activities. Some of the crucible manufacturers sought the entire output of several of the Alabama mills, but some of them were at that time fully contracted.

This encouragement from the consumers and the determined policy of the Government of insisting on greater activities induced large amounts of capital to enter the business. Investment in the Alabama field increased from possibly \$150,000 in 1914 to about \$4,000,000 in 1919. This capital increase of over three and three-fourth million dollars in the Alabama graphite industry was secured without any financial assistance from the Government, which assistance in numerous instances was an indispensable factor in the rapid development of many of the war essentials. However, the force of governmental insistence was carried to the point of threatened confiscation should the result of private effort be unsatisfactory.

The Government continued the same method of stimulating graphite production up until late in 1918, when they sent an agent to the Alabama field and again warned the producers of the danger of underproduc-

tion, predicting dire results should the consumers call for more than the limited percentage they were required to use of the domestic product. Investors naturally turned to the Government for relief. A petition was submitted to the Ways and Means Committee of the House in September, 1919, pleading for a duty on the foreign material that would equalize the difference in production costs between this country and the foreign supply, but the bill never was reported out of the committee.

The election of President Harding was won on the promise of protection to American industries. One of the first acts of the present House was the passing of an Emergency Tariff bill, which was exclusively agricultural. These same agricultural interests had been riding on the crest of a prosperity wave for nearly eighteen months after the graphite business had been ruined.

Is it not time to question the motives of Congress in their treatment of these essential industries? Or will the Government's pledges be ultimately redeemed by impartial legislation for every section and for all industries of the country, whether they are of a manufacturing character or producers of raw materials?

The domestic producers of graphite met every requirement of the Government in providing rapidly facilities for turning out the full amount and grade required by the War Boards. The investments of crucible manufacturers in their crucible plants would not equal the capital invested by the producers of graphite, yet the manufacturers of crucibles have been protected by a tariff on foreign-made crucibles for years.

Soon after the cessation of hostilities all restrictions on the importation of foreign graphite were removed. The manufacturers immediately followed the usual

commercial policy of securing their supply from the cheapest source. They now are able to draw from the large Oriental surplus at prices as low as they had been for years before the war.

Congressional action, on the plea for relief to the domestic graphite producers, will determine the future of the industry, which recently was considered so important to our national security. It either will secure our national independence in graphite supplies or it will leave us, in the event of war, at the mercy of our enemy in procuring this material from the opposite side of the globe.

Men Wanted for Development Work of the Bureau of Chemistry

The office of Development Work has recently been created in the Bureau of Chemistry of the United States Department of Agriculture for the purpose of assisting in the industrialization and commercialization of chemical processes and discoveries worked out in the laboratories of the Bureau. The chemical engineers in this branch will endeavor to design mechanical equipment to place the processes on a plant production basis and determine the manufacturing cost and market value of the products.

The chemical discoveries relate to the utilization of waste agricultural materials for new purposes and to the deriving of new substances from farm products. One of the projects undertaken has been the production of syrup from sweet potatoes. (See *CHEMICAL AGE*, April, 1920.) The process as worked out in the laboratory has been very satisfactory. Chemical engineers in the Development Division are now endeavoring to obtain data to assist in the establishing of a sweet potato syrup production industry if the scheme is commercially feasible.

Another project to be undertaken in the near future has to do with deriving from corn cobs (see *CHEMICAL AGE*, September, 1920), furfural, cellulose flour, and two grades of adhesive. Other lines of work following up closely the methods determined in the laboratory will be undertaken. The industrial contact for the Bureau will be handled through this new division, and the engineers will be called upon to maintain satisfactory industrial relations with the business interests of the United States.

In connection with this development work the United States Civil Service Commission will receive applications until June 21 for positions of associate development engineer, at salaries from \$2,500 to \$3,600 a year; assistant development engineer, at salaries from \$1,800 to \$2,500 a year, and junior development engineer, at salaries from \$1,440 to \$1,800 a year. Appointees at annual compensation of \$2,500 or less whose services are satisfactory will be allowed the increase granted by Congress of \$20 a month.

Applicants will not be required to report at any place for examination, but will be rated upon their education, training and experience as shown by their own statements and by corroborative evidence, and upon published writings or these submitted with their application. They must qualify in at least one of eleven specified engineering branches.

The requirements for entrance to these examinations and other information in full, together with application blanks, may be obtained by communicating with the United States Civil Service Commission, Washington, D. C., or the secretary of the local board of United States civil-service examiners at the post-office or custom house in any city.

Workmen's Compensation Law in New York

EDITOR, *CHEMICAL AGE*:

The workmen's compensation law of this state secures compensation every year to thousands of injured employes and their dependents who could not have recovered anything under the technical rules of law in negligence actions.

The very backbone of the compensation law is the requirement that every employer subject to its provisions shall secure and make certain payment of compensation awarded to his injured employes by taking out insurance with the State Insurance Fund or with a private casualty company or mutual insurance company or by depositing securities with the Industrial Commission.

Failure to carry such insurance is made a misdemeanor, punishable by a fine of not exceeding \$500 or by imprisonment up to one year, or by both.

The Industrial Commission has sought in every way to secure compliance with this law. It has brought several hundred criminal prosecutions against uninsured employers as the result of inspections and complaints. With the co-operation of the Court of Special Sessions the Commission has secured heavy fines, and in a number of instances severe jail sentences, ranging from thirty days to six months, against employers who failed to carry insurance and whose employes were killed or severely injured.

The Industrial Commission has been most zealous in enforcing the payment of awards against uninsured employers, having collected in the last year upward of \$135,000 from that source.

Despite all these efforts there are numerous cases every year where compensation awards cannot be collected because the employers are financially irresponsible and have failed to carry the insurance that the law requires. Pathetic cases could be mentioned of widows and orphans and of crippled workers who have been thrown upon public and private charity because of the violation of this provision. It is a great social wrong and fosters in the hearts of the victims a spirit of discontent, for they cannot understand why the humane workmen's compensation law has broken down in their cases.

Publicity is the greatest cure for this condition. Uninsurance is due not so much to wilful violation as to indifference and to ignorance of the law. Small employers are often ruined financially because they have failed to carry insurance, and the uncompensated victims of industrial accidents are forced into lives of suffering and want.

Employers may obtain information concerning their liability under the compensation law by addressing the office of the Labor Department, 124 East 28th St., New York City.

BERNARD L. SHIENTAG,
Counsel, State Industrial Commission. Albany, New York.

Recovery of Constituents of Old Motion Picture Films

By M. Deschiens

THE treatment of discarded motion picture films for their recoverable values constitutes, because of their quantity, an important adjunct of the cinematographic industry. The numerous patents granted for processes designed to recover valuable constituents have for the most part little industrial application.*

Before devising a process to recover film ingredients it obviously is essential to know what these are. This discussion applies to an unflammable film of the cellulose acetate type. Such a film consists of three layers: (1) a bottom layer of transparent cellulose acetate and plastic materials. In the ordinary film the basis is nitro-cellulose. This layer varies from 0.12-0.15 mm. in thickness, and forms approximately 65-70 per cent. of the weight of the film; (2) an intermediate layer of sensitized gelatine 0.01-0.02 mm. thick; (3) a thin top-coat consisting of a mixture in the following proportions of

Amyl acetate....	750 cm.	Camphor	12.5 grams
Benzine	250 cm.	Castor Oil.....	12.5 grams
Nitro cellulose.	38.40 grams		

This thin top-coating by inhibiting the action of the solvent on the intermediate gelatine layer causes much of the trouble in processes for the recovery of film ingredients.

The methods of recovering the constituents of old films that have been used up to the present time may be classified as follows: (1) processes involving solution of the cellulose esters by comminution and kneading; (2) bio-chemical processes; and (3) chemical processes.

Comminution-Kneading Process

The process is carried out in closed vessels wherein agitation of the film and solvent is effected by either horizontal or vertical shafts to which are attached suitable arms. For every 500-1000 grams of film are used about 10 kilos of a solvent such as tetrachlorethane and alcohol, acetone, methyl acetate or ethyl formate or phenolic compounds, as e.g., the cresols.

In the writer's experience the most suitable solvent is composed of a mixture of 50-60 per cent. of technical tetrachlorethane and 40-50 per cent. of methyl acetone containing about 50-60 per cent. of acetone. Crude cresol also can be used either alone or diluted with methyl, butyl or methylene alcohol. In any case the alcohol-content should not exceed 50 per cent. of the mixture. Nitro-benzol also has been recommended as a solvent.

The solution thus obtained is filtered through a metallic web, or a filter press of the type used for filtering collodion. The residues are washed with additional solvents and refiltered. Finally only the gelatine and silver salts remain behind on the filtering medium, which are dried and ignited to recover the silver salts.

The silver obtained from 100 kilograms of film is worth 40-50 francs, which at the present price of silver, amounts to about 10 cents per pound of film. The calcined ash containing the silver can be converted into nitrate by means of nitric acid, or used to make silver bromide.

The solution of the cellulose ester can be concentrated *in vacuo* and, after the addition of material to render the mass plastic, i. e., until a syrup, liquid or solid mass is obtained, it might be used for the manufacture of new film. Another procedure consists in precipitating the gelatine with cold water. By this process the gelatine only is lost. This process apparently would be the most advantageous were it not for the fact that a portion of the solvent is lost in the reworking of the film up to this point.

Lixiviation

A new process of reworking old films consists in leaching them with suitable solvents. It possesses commercial value and is technically correct. A distinct advantage of this process, as compared with the foregoing method, is the fact that only about two-fifths of the solvent are required, viz., about 3.5 to 4 kilograms of the solvent to one kilogram of the film. The recovery of the solvent is much more effective and the cost of that particular reagent is reduced to a minimum. Such a process has been invented by J. H. Bregeat and patented in France (French Patent No. 493211).

The old films or other technical wastes, such as celluloid dust, cuttings from the coated fabrics used in the manufacture of aeroplanes, filter press cake from collodion manufacture, etc. are first freed from any fatty substances that they may contain. Then they are leached in suitable extractors with the proper solvents. In this manner, there is obtained a solution of the cellulose ester, and the textile fabric and other foreign material, such as the silver salts, are undissolved.

When it is desired to obtain the ester in the form of a varnish, then the proper solvent is chosen. On the other hand if it is desired to produce a powdered substance, then the solvent is distilled off and the mass that thus obtained is precipitated with cold water in the closed vessel of the type described above. The aqueous solution, which contains still a little solvent, is distilled to recover the same. According to the patent specifications, the cellulose acetate dissolves in warm nitrobenzol within 12 hours. Nitroxylol also can be used instead of nitrobenzol. Furthermore, hot benzyl alcohol as well can be employed for this purpose. In this case, the cellulose acetate is obtained in the form of a jelly after the mass has been cooled. During the War, in the Thaon bleach works the ester was recovered from old aeroplane cloth by aid of the usual solvents and also by means of various phenol compounds.

Biochemical Process

The basis of these processes is the action of diastase, or pepsin in particular, on gelatine. The cellulose ester does not undergo any change. The films, either in the original state or ground up, are treated with a dilute aqueous pepsin solution at 37° C. for 24-48 hours. The gelatine is peptonized and goes into solution. The silver salts separate out as a precipitate and can be processed to recover the silver. After the film has been treated in this manner without being first ground up, then, after it has been washed with hot water, carefully brushed off and dried, it can be used as such as a new film without any further treatment. This very delicate

*Rev. Prod. Chim.: 23, 591-2. *Chemiker Zeitung*: 46, 259-210.

process has been patented in Belgium (Patent No. 218192) and in France (Patent No. 413500). The only loss in the process is the gelatine.

Chemical Processes

A very well-known chemical process of reworking old films consists in treating them with a cold aqueous solution of sodium hypochlorite. This substance attacks the film, causing the gelatine layer to swell up. The films are then brushed off and washed.

Another method of removing the gelatine layer consists in subjecting the film to the action of a 10-20 per cent. soda solution at 50-80° C. Considerable care must be taken in carrying out this process that the soda solution does not saponify partly the cellulose ester and thereby deteriorate the film. In addition, the silver is recovered by means of

cyanide solution, the gelatine with hot water and the cellulose with suitable solvents.

The British Aeroplane Varnish Co. Process

The British Aeroplane Varnish Co. process consists in treating the nitro-cellulose film with a compound solvent, containing acetone, benzine, alcohol, etc. In general about 91 kilograms of the film are dissolved in a mixture, composed of 227 kilos. of methyl ethyl ketone (acetone or methyl acetate can be used instead of this constituent, 387 kilos. of benzine, 308 kilos. of alcohol, 20 kilos. of zinc chloride or calcium chloride and 0.5 kilos. of citric acid.

The cellulose esters that are recovered by these processes can be used in the manufacture of artificial leather, and for the various purposes for which the original material is adapted.

Expansion in Match Manufacture

W. A. Fairburn, Chicago, Ill., president of the Diamond Match Co., reports in substance of the technical operations of his company for the past fiscal year:

Chemical Plants, Etc.—When the importation of potash from Germany was abruptly terminated by the war we were compelled to make our own muriate of potash. Three processes were developed and three plants built; all successful. The most economical plant, that at Burmester, Utah, was later enlarged to take care of our entire needs, and continues in operation. Certain other chemicals and ingredients were also necessary for match composition. Experimental plants were built and during the past year a compounding and organic chemical plant has been erected at a cost of \$202,500 and certain producing experimental plants have been enlarged and important manufacturing processes developed.

The cost of our chemical plants erected during the war and post-war periods has been \$1,599,272, not including the recently built organic chemical plant. Of this amount we have written off and charged against operations the sum of \$1,444,380, so that these emergency and experimental plants are now carried on the books at only \$154,892.

It may become necessary to build electrolytic chemical plants within the next few years, but such construction, being expensive, will not be undertaken unless we are driven to it in order to maintain our position.

Strike-on-Box Matches.—During the war we were compelled materially to increase the output of the strike-on-box foreign type of match at the factories in Barberton, O., and Chico, Cal., and to build a war match plant at Savannah, Ga. The strike-on-box departments have continued steadily in operation, but we plan materially to curtail their production and gradually to remove the machinery or rebuild it for other types of matches. The Savannah plant will continue of importance, as it is the only Diamond Match plant located on tidewater, the 19½ acres having a very desirable frontage on the Savannah River, which is navigable by deep draught vessels.

Lumber Plants, Etc.—Because of railroad congestion we were compelled to erect a large war plant at Spokane, Wash., for the storage and seasoning of white pine lumber and the manufacture of match blocks. With increasing freight rates this plant has become more and more of an economic factor.

Early in 1920 unprecedented conditions in the Idaho white pine lumber market led us to purchase standing timber, felled logs and, in some cases, lumber manufac-

turing plants for our match manufacturing operations.

During the year also commodious storage buildings were erected at each of the manufacturing plants, taking the place of lumber piles.

The California timber holdings are still held substantially in reserve. The annual cut is in harmony with the existing facilities of the Chico match factory and normal healthy demand of the general lumber business of northern California. California sugar pine is not the ideal match block lumber, and, moreover, it is too valuable in the national lumber market to be used generally for match plank purposes.

Handy Pocket Match.—This diminutive type of book match is primarily a high-class cardboard and printing job, and can only be distributed profitably when coupled with advertising and catering to the needs of small as well as big business. Because of its peculiar handy and safe properties, it has become increasingly popular, and during the past year it became necessary to prepare by a large capital outlay for the increasing demand for this class of goods, together with the erection of a large cardboard operating, printing and book match assembly plant at Springfield, Mass., and the addition of a large wing for similar purposes at Barberton, Ohio.

Science Service

E. W. Scripps, newspaper publisher, has endowed an institution called "Science Service," with present headquarters at the office of the National Research Council, Washington, D. C., and a board of trustees comprising three representatives each of the National Academy of Sciences, American Association for the Advancement of Science, National Research Council, the journalistic profession and the Scripps estate.

Science Service is to publish books and magazines, conduct conferences and lecture courses, to produce motion pictures and write popular stories on scientific subjects. Edwin E. Slosson has been appointed editor of the Service and makes the following announcement:

"The editor of Science Service desires to receive advance information of important researches approaching the point of publicity in order to arrange for their proper presentation in the press. He also wishes to secure correspondents in every university and center of research who have the time, disposition and ability to write for non-technical journals. He particularly wants to get in touch with young men and women in the various sciences who have literary inclinations and would be willing to submit to a rigorous course of training with a view to making the writing of popular science a part of their life work."

Technical Research and the Textile Industry

Advice on the Essentials of Technical Progress of General Application in Industry

By Benjamin T. Brooks

Chemical Engineer, Mathieson Alkali Works, Inc.

THE National Association of Cotton Manufacturers naturally is interested in research, and every member of this association knows that technical research is one of the most important paths of industrial progress.* To begin with, let us agree as to what we mean by research. We may very aptly use four headings employed by Professor Irving Fisher in considering the present problem of industrial reconstruction, viz., 1. What is it? 2. Why is it? 3. What of it? 4. What are you going to do about it?

Technical Research

And so, taking our cue from Professor Fisher, we may ask "What is technical research?" We hear so much about chemical research that "research" in the industries has become almost synonymous with chemical research. One of the first things to make clear is that chemistry has no monopoly of research. However, chemists constitute easily the largest class of technical men trained in the methods of research, and by methods of research I mean not only methods of experimentation, but also familiarity with economic factors and the relations which technical research must bear to a particular business.

Also chemistry bears a fundamental relation to practically all industry and taking these two things into consideration, it is not surprising that the majority of those directing technical research in industries where chemistry is of secondary importance are generally men trained in chemistry. Thus, one of our large electrical corporations chose a chemist to direct its research, and this particular institution has been conspicuously successful. The Eastman Kodak Company is another illustration of the same thing, their research being directed by Dr. C. E. K. Mees.

The chemist primarily is an investigator as the engineer primarily is a builder. When engineers spurn the investigator and undertake to build experimentally, the result is apt to be as costly as when the investigator attempts to usurp the engineers' function; we must have team play in such matters.

Fundamental Character of Chemistry

Permit me to emphasize that chemistry bears a fundamental relation to all industry. In the literature are recognized as many as twenty-eight general branches of chemistry and chemical technology. I will not enumerate them, but wish to point out that, although there is not a single important industry that is not re-



BENJAMIN T. BROOKS
Chemical Engineer,
Mathieson Alkali Works, Inc.

ceiving assistance and aid from chemical investigation, it is too much for industrialists to expect that we can thrust our research burdens on to the universities. If we attempt it many of us will be very badly served. And this leads me to plead that we must leave our universities free to carry on fundamental investigations; in fact, we must insist upon it, so far as we may have influence, that they do carry on such investigations. This affects the plans of this association very directly, and there are other phases of this, which I shall mention presently.

Economics of Research

Research suffers from a few enthusiasts who differ from Mr. Ponzi chiefly in being conscientious and believing in their preachments. Research, however, is not a broad highway to easy money. All who have had experience in the development of industrial processes or have seen much of such development from the first discoveries in the laboratory to successful commercial operation of a given process, know that the cost of laboratory research is the smallest part of the total. This is one reason why associations such

as the National Association of Cotton Manufacturers can prosecute industrial research to great advantage. For example, you have many large plants where processes which have been carefully demonstrated in the laboratory can be tried out on a large scale with a minimum of delay and expense.

I wish to point out the true relation of laboratory research to the business it is intended to serve. It is futile, or at least bad business policy, for any business enterprise to prosecute research for which there is no provision for industrial adaptation and development. This point is worth emphasizing because the picture usually presented by persons inexperienced in industrial research is one of a few thousands dollars being spent in a laboratory investigation yielding millions in return almost automatically.

Did the discovery of viscose by Cross and Bevan create the artificial silk industry? Every one knows that it did not. In the same way the very excellent researches of Peter Griess on the diazo reaction did not create a diazo dye industry any more than the discovery of the refining action of sulphuric acid of petroleum oils by Benjamin Silliman in 1856 created the petroleum industry. The ammonia soda process was patented by Dyar and Hemming in 1838, but it was not until 1865 that Ernest Solvay was able to operate the process successfully on an industrial scale. The synthesis of ammonia from nitrogen and hydrogen has been a laboratory success for about ten years, but several industrial

*Address before the National Association of Cotton Manufacturers, April, 1921, Boston, Mass.

groups are still struggling to place it upon a basis of successful commercial operation (the Haber plants, operated in Germany during the war, are probably farthest advanced in this art). These facts enable me to point out another great advantage open to this association. The chances that one or two men, working alone, will discover and develop anything of great value are exceedingly remote. The chief characteristic of modern inventive work is group co-operation and group thinking. Haber and Rossignol had the assistance of the whole Badische Company's organization to assist them in their work on ammonia synthesis. My point, therefore, is this: If your central research organization can draw freely upon the knowledge and experience of your members the net results should be a piece of whole cloth, the individual threads of which you would find it difficult to trace. The maximum result is attainable only in this way. You cannot expect such a research organization to shower good things down upon you from some laboratory of Olympian seclusion.

An Old Story

There are doubtless some manufacturers in this association who will expect to give nothing and receive everything, and who perhaps imagine that they possess valuable "secrets" or perhaps what may more aptly be called "tricks." Most great industries have passed through a stage in which secrecy has been much prized, but this is no longer characteristic of our most progressive and successful enterprises.

Only a few years ago practically every glassmaker and manufacturer of glazed wares possessed a formula or two which he kept carefully locked in his safe and, in many cases, gave fictitious names to his raw materials, doctored his scales so as to give false weight readings, and used other such devices calculated to preserve his secret. But when those interested in the improvement of the whole industry began to publish glaze and glass formulae and other scientific data, most of these manufacturers discovered that they were using identical formulae or, in a few cases, discovered that they were a generation or two behind the times and, accordingly secrecy in this industry has been largely thrown into the discard.

About four years ago the tanners started a central research laboratory in which fundamental investigations of benefit to the whole industry were to be carried out. However, the usefulness of this laboratory has been almost nil and for many reasons, chief among which is the fact that many of the best informed tanners supported the laboratory with money only, but refused to assist in other ways because they imagined they possessed valuable secrets. Other tanners attempted to utilize or monopolize the laboratory for the solution of petty private problems peculiar to their own plants, and it was found necessary to control such abuses by creating a small board of control to which such matters could be referred.

Research Recommendations

Having introduced a word or two of caution as to what can be expected of industrial research, we may make use of the last subject heading of Mr. Fisher's, viz., "What are you going to do about it?" What specifically is to be recommended in case this association desires to proceed with research.

First let it be emphasized that the success of such an undertaking will be largely determined by careful planning by your committee. Before setting forth my own suggestions, permit me to state certain premises, which easily can be proved.

- I. Research cannot be done effectively in the spare time of a professor or anyone else. University professors, contrary to popular opinion, are hard working men and nearly all American universities are badly overcrowded with students. Time is altogether too important to you to wait upon the uncertain results obtained in the spare time of these already very busy men.
- II. Students are not sufficiently trained to do work of any value, even under good direction; their minds are occupied by a multitude of other things. Professor T. W. Richards, of Harvard, has told me that seven or eight well trained post graduate students is as large a number as he can direct effectively in research, and there are few men, indeed, of the calibre of Professor Richards. His assistants are also carefully selected; therefore, when anyone proposes to solve your problems by means of undergraduate students in university laboratories they are talking nonsense.
- III. Direction of research cannot be left to a committee.
- IV. Research on problems that are worth while should be guaranteed for a period of at least four or five years.
- V. The actual experience of companies who maintain industrial research is that the investigation of big problems, usually difficult, pays better in the long run than the solution of a multitude of little, easy problems.

Essentials of Research Direction Examples

Research is best directed by one who has had very broad theoretical scientific training rather than by one who has spent a great many years in close application to plant problems. This statement needs further explanation, best made by one or two illustrations.

Several years ago the sugar planters' association in Hawaii maintained a research laboratory under the direction of Noel Deerr. One of their most serious problems was the eradication or control of a beetle which formerly was not found in Hawaii. Mr. Deerr turned a deaf ear to suggestions of applying insecticides and such like measures, and because of his broad scientific training and broad outlook he reasoned that since this particular beetle had become highly specialized and lived only upon the sugar cane and deposited its eggs in the sugar cane, that it must have taken several thousand years for such a high degree of specialization to have been brought about. Having been much interested in the history of cane sugar, he at once was able to eliminate most sugar producing countries as the home of the beetle. He searched for a trained entomologist of sufficient hardihood to undertake the search for the natural habitat of the beetle with the expectation, again guided by biological knowledge, that a natural enemy of the beetle would be found.

The entomologist of the required character was found in a telegraph operator stationed at a lonely point in South Africa, from whence he had been sending in studies of entomology for publication, and in this way had become known. This entomologist soon found the beetle in New Guinea and, as surprised by Mr. Deerr, found a natural enemy of the beetle, which also had become quite highly specialized, so that it preyed only upon this particular beetle. A number of sugar cane plants containing both the beetle and its parasite were shipped to Hawaii and stations were established throughout the Islands, from whence the parasite was distributed. The practical result of this matter was that without any further effort the yield of sugar on these plantations was increased approximately ten tons per acre. In all probability, a man of narrower vision than Mr. Deerr would be spraying the Islands yet with insect powder.

My second illustration is one which does not involve such large money returns, but shows how easy it is for a man of the proper scientific knowledge to turn little things to practical account. Dr. F. J. Metzger, of the Air Reduction Company, directs their researches having to do with the synthesis of ammonia, liquefaction of gases, preparation of pure oxygen and nitrogen from liquid air and such matters. You will recall that atmospheric nitrogen contains a small residue of the rarer gases discovered by Ramsay, viz., Argon, Neon, Krypton and Xenon. Knowing that the discharge of electricity through these gases in a much rarefied condition, as in a little glass tube exhausted to a high vacuum, produced brilliant spectra, it was very simple for Dr. Metzger to twist his little glass tube into the form of the human hand, attach it to the rear of his automobile and when stopping or turning a corner he merely presses the button and flashes a brilliant scarlet hand as a signal to those behind. Automobile interests have already taken up this matter, and this little toy without exaggeration may be said to be the product of a few hours' play on the part of Dr. Metzger.

In this connection, I should like to point out that during the war, a great many entirely new problems were solved and important new discoveries made, but not one of them was made by any of our famous inventive wizards. Professor Michelson, of the University of Chicago, increased the effective range of our field guns from three to five miles simply by calculating mathematically the proper curvature of the shell.

In England, after many trials and tribulations, the manufacture of explosives, the necessary chemicals for their manufacture and chemicals for other war purposes was placed under the autocratic control of Mr. K. B. Quinan, who proceeded to gather together about fifty of the best most thoroughly trained theoretical chemists, who had been turned out of English universities in the few years just prior. He put these young men through about three months' intensive instruction and placed them in charge of the technical work of these munitions plants, and contrary to all prediction, the plan worked, and with such a conspicuous degree of success that you would have to hunt very hard in England today to find any critics of Mr. Quinan's plan. Practical men who have spent years in plant operations are greatly needed in council and their observation and experience are of the greatest value as an aid to research but they should not undertake to direct research.

Research Suggestions

There are many possible plans of carrying out research for an association such as this, and I realize that normally all of you are very busy men and have little time to give to the details of management of such a scheme.

One plan would be to have a committee draw up a list of problems, the solution of which is needed, and distribute this to instructors in universities or textile schools, but in my opinion this is about the worst plan which could be adopted, for reasons which I have already indicated.

It would be very satisfactory to organize, equip and maintain your own research laboratory, but the chief objections to this are (1) its relatively great cost, and (2) the uncertainty as to whether or not the association would continue to believe in the wisdom of expending no small sums of money in this way. In my opinion, after this idea of a research for the benefit of the whole association has been given a thorough trial of say four to five years, and the benefits therefrom can be shown

to be such as would reasonably warrant the expenditure, then you might be justified in appropriating funds for building your own laboratory. In Germany such a laboratory has been built for the sugar interests and maintained in Berlin.

The plan which I would recommend to you is briefly this: Utilize the splendid facilities for research which exist and are available to you at institutions such as that of Arthur D. Little, Inc., Cambridge, Mass., or the Mellon Institute of Industrial Research, Pittsburgh, Pa. Each of these institutions is devoted entirely to research, and has laboratories and miscellaneous scientific equipment costing several hundred thousands of dollars. They are both located where they have access to excellent technical libraries, and one of them, A. D. Little & Co., has had considerable experience with problems relating to cellulose, paper pulp, textiles and dyes.

Information of value to you would be derived through at least five channels, viz.:

- I. The solution by intensive investigation of specific problems selected by your committee or the director of research whom you will appoint.
- II. The solution of problems which only can be investigated by actual plant operations on an industrial scale, such work being done in your own plants, as there are doubtless many manufacturers in this association who gladly will take up problems of this nature.
- III. A third channel of information which may prove to be astonishingly productive will consist in bringing together information, now scattered among your various members, but never brought together, and I might say edited by a man such as your director of research will be. I do not mean by this, that such information will consist merely in giving up secrets which may be of real value to certain manufacturers, but it very often happens that a certain fact which has been commonplace through long familiarity with it contains the germ of something very important and valuable. Elements of the solution of many problems already may exist in different plants, and these may be brought together to the advantage of all.
- IV. With proper diplomacy, it easily is possible that many problems, the solution of which would be valuable to you, can be worked out by co-operation with and by and at the expense of others. For example, experimental work on dyes and dyeing, mechanical investigations, such as wearing and strength tests of fabrics for automobile tires might very well be taken up by other interested parties. Your research director could keep in touch with such researches; even perhaps instigate them.
- V. Your research director might also abstract the scientific literature and give you bulletins concerning research published elsewhere relating to your problems. One very large research institution claims that in their experience about 80 per cent. of the industrial problems submitted to them were answered directly by search of the scientific and technical literature. This last item is worthy of particular emphasis.

Of course, industries, like individuals, never do as well as they know how, and an amazing proportion of scientific information fails, for various reasons, to "get across" to those who can best make use of it. One reason for this, which investigators seldom appreciate, is the appalling number of absurd schemes which almost daily are presented to large business concerns. Your research director should assist in sifting the wheat from the chaff and he, together with his assistants, could examine, and in many cases, test such new propositions. If this association is like all other manufacturing enterprises no small amount of money is annually wasted by various individual concerns on new propositions which are technically unsound or, occasionally, even ridiculous.

Available scientific information is too frequently overlooked. Permit me to cite three examples which

particularly are worthy of notice because those who suffered from the oversight were themselves scientific men. The diary left by Scott on his tragic polar expedition plainly states the chief cause of his failure to reach safety was that the alcohol and gasoline left by him in his supply depots mysteriously leaked away and was lost. Many of the cans were entirely empty when found on the return journey. That tin and alloys rich in tin, such as pewter and solder, disintegrate in very cold weather to a gray powder, the allotropic form of tin, has been known for many years and the phenomenon was thoroughly studied by van Eijck and Cohen in 1899. Yet in 1912 Scott, according to his own diary, lost his life and his expedition failed largely on account of not knowing this simple fact. Since then welded containers have been used for shipments to polar regions.

Recently the American Museum of Natural History lost the valuable pelts collected in South America during two or three years, because they did not know that hides "tanned" by sulphuric acid and salt would soon fall to pieces. During the first years of the war the steel makers were scouring the country for deposits of high grade magnesite. The very high grade magnesite now being shipped out of Washington was "discovered" in 1916 by a lumberjack, although the deposit had been thoroughly described, with complete chemical analyses, in 1902.

In conclusion, permit me to reiterate that the success of research such as you contemplate will depend very largely upon the way you go about it and upon the fullness with which you co-operate with your research men, once they have undertaken their part of the work.

Metal Protective Paints

By Henry A. Gardner

THE causes underlying the corrosion of steel, and the principles to be adopted in designing protective paints are well understood as the result of comparatively recent work.¹

Principles of Paint Protection

The manufacture of the majority of high-grade paints now produced is based upon these principles.² Briefly stated, they are as follows:

1. Basic substances in sufficient concentration inhibit the corrosion of iron. Basic pigments that are effective for this purpose are litharge, red lead, blue lead (basic lead sulphate), white lead, zinc oxide.

2. Chromic compounds (soluble bichromates), even in great dilution, prevent the corrosion of iron. Chromate pigments that are similarly effective when used in sufficient amounts are as follows: basic lead chromate, normal lead chromate, zinc chromate.

3. Neutral substances that do not ionize to acid reaction are considered inert. So-called neutral or inert pigments, such as iron oxide, which do not excite corrosion, produce with linseed oil very durable films. Such pigments include black, brown and red oxides of iron, china clay, silica, talc, and barium sulphate.

4. Substances that form a galvanic couple with steel in the presence of moisture cause rapid corrosion. Pigments which act in this fashion (graphite, carbon black, lampblack) are used only as constituents of the finishing coats on steel surfaces, when first insulated from the metal by a coat of basic or chromate pigment paint. These carbon pigments with linseed oil form very durable and water-resisting coatings.

Proper Pigments for Metallic Paints

From the above data it is apparent that paints for priming steel should preferably be made of a substantial amount of one or more basic or chromate pigments, and that these paints should be covered with water-resisting finishing coats of carbon or iron oxide paints. For instance, steel that has been primed with high-grade red lead paint and finished with two coats of a carbon paint will be protected from corrosion under most conditions for a long period of time.

In many instances, high-grade proprietary primer paints contain a mixture of red lead, chromate pigments, iron oxide and zinc oxide. The finishing coats

of such paints contain carbon black or lampblack, generally with 5 per cent. of litharge, and often certain amounts of iron oxide and silica. The liquid for such paints is raw or boiled linseed oil with a total of about 15 per cent. of liquid drier, turpentine or mineral spirits. Where high gloss is desired, the addition of spar varnish is indicated.

In many places the use of black or other dark colored finishing paints may be objectionable from an esthetic standpoint or because of their gloomy appearance. Light-gray paint made of white lead and zinc oxide, or of zinc oxide and barium sulphate (navy practice), tinted with lampblack, have been used as finishing coats on steel bridges, government structures and vessels. While possibly not as durable as red or black paints, they give much higher light reflecting values and are of more pleasing appearance. For use around acid and chlorine factories, black bituminous coatings have usually been adopted.

Of recent years, however, there has come a demand for white and light-colored paints. The only white opaque pigment for such paints that is insoluble in most acid gases is titanium oxide. This pigment, which is now produced by an electrochemical process and contains 25 per cent. of titanium oxide precipitated on 75 per cent. of barium sulphate, possesses tremendous hiding power. It is usually applied with up to 40 per cent. of zinc oxide to give it sufficient hardness. In white or tints, such mixtures are very durable.

Various metal powders are now being applied to some extent as constituents of metal protective paints. When applied direct to steel surfaces, zinc powder and aluminum powder have much greater rust-preventing properties than the powders of other metals, on account of the high electro-positive nature of zinc and aluminum. Because of the great light-reflecting properties of aluminum powder, its use is indicated for special purposes on exterior work. Probably the most satisfactory liquid for suspending this powder is a high-grade exterior spar varnish. When used with linseed oil, a rather slow drying paint results.

Conclusion

Standard painting practice for iron and steel calls for the application of a primer containing basic or chromate pigments. Finishing coats generally contain red oxide or black carbon pigments. A wider use of white and light-tinted paints of high light reflecting power is indicated for many purposes as finishing coats.

¹ Presented at the Thirty-ninth General Meeting of the American Electro-chemical Society, Atlantic City, April 21-23, 1921.

² Corrosion and Preservation of Iron and Steel—Cushman and Gardner. Paint Researches—Gardner; Papers on Paint and Varnish—Gardner.



Plant of New England Oil Refining Co., Fall River, Mass.

Petroleum Refining in New England

WITH the completion of the petroleum refinery of the New England Oil Refining Co. on the Taunton River at Fall River, Massachusetts has added to the industrial empire of New England an enterprise already represented by the refineries of the Beacon Oil Co. at Everett and the Massachusetts Oil Refining Co. on Fore River at East Braintree. The refinery of the Beacon Oil Co., backed financially by the Massachusetts Gas Companies, was described in October, 1920, *CHEMICAL AGE*. The administrative staff of the Massachusetts Oil Refining Co. at East Braintree comprises: W. C. Robinson, president; A. J. Maguire, vice-president; P. W. Wilkins, general superintendent; F. A. Williams, plant superintendent, and Joseph V. Meigs, chief chemist.

New England Oil Refining Co.

The New England Oil Refining Co. is a Massachusetts corporation whose capital stock of \$7,500,000, subject to \$5,000,000 first mortgage bonds (\$3,000,000 issued), is owned by the New England Oil Corporation, a Virginia incorporation. The officers of the refining company comprise: Llewellyn Howland, president; Gaspar G. Bacon and W. W. Boyd, Jr., vice-presidents; G. F. Olsen, vice-president, formerly director of refineries of the Union Oil Company of California; Charles B. Buerger, formerly chief engineer of the Atlantic Refining Co.; Edwin B. Hopkins, petroleum engineer and geologist, formerly of the Texas Co.; Luis De Florez, formerly refining engineer of the Texas Co., and F. G. Ring, formerly of Gray & Ring, petroleum engineers.

Among the directors are the following representatives of financial interests: F. Douglas Cochrane, chairman; Rodolphe L. Agassiz, president Calumet & Hecla Mining Co.; Gaspar G. Bacon, vice-president; Spencer Borden, Jr., of National Shawmut Bank; Herbert W. Briggs of E. H. Rollins & Sons; Allan Forbes of State Street Trust Co.; Llewellyn Howland, president; George F. Naphen of Naphen & Co.; Bradley W. Palmer of United Fruit Co.; Charles E. Perkins of C. B. & Q. R. R.; John B. Shearer, vice-president of Invincible Oil Corporation; George W. Treat of E. H. Rollins & Sons.

New England Oil Corporation

The New England Oil Corporation, in addition to owning the New England Oil Refining Co., has interests of the first magnitude in the Maracaibo Lake region of Venezuela, covering over 500,000 acres of oil lands in the process of development. The leases or concessions with respect to 250,000 acres are adjoining the holdings of the Carter Oil Co. and other important oil interests. The corporation also has a drilling contract with the Sun Oil Co., through which it will ac-

quire a half interest in twelve concessions amounting to about 500,000 acres, owned by that company.

The two companies have planned for a joint operation on any concession where oil is developed. The United Fruit Co. has a direct interest in this Venezuelan acreage, having a contract with the New England Oil Corporation for part of the first oil produced in its South American acreage and an option to participate in certain further developments. The interests which control the New England Oil Corporation are also closely identified with the ownership and management of the Invincible Oil Corporation, a large producer of crude oil in the mid-continent field.

The Refinery

The refinery, having a rated daily capacity of 20,000 bbls. of crude oil and covering 46 acres of land, was built under the direction of the C. B. Roberts Engineering Co., 19 Milk St., Boston, Mass., and represents the highest type of construction in oil refining. The administrative personnel of the constructing organization embraces C. B. Roberts, president; T. T. Gray, petroleum technologist; F. G. Ring, director of refinery engineering, and C. H. Hollingsworth, construction manager.

The equipment of the refinery includes a topping plant, consisting of two tubular topping stills and five 1,000-barrel shell topping stills set in series; a coking plant, consisting of two batteries of ten 1,000-barrel shell-type stills with concrete condenser boxes; a treating plant and rerun plant for finishing gasoline; a tank farm, consisting principally of 55,000-barrel steel tanks, carefully protected by concrete and earthen dikes; a boiler plant with a maximum capacity of 2,150 horsepower; a pump house with steam-driven duplex pumps; a salt-water pumping station with a capacity of 6,500,000 gallons a day; a distribution station for electric light and power; over fifty miles of underground pipes laid in steam-heated conduits, and all other needful apparatus and conveniences for the operation of the plant and business.

The docks at Fall River provide simultaneous facilities for four 10,000-ton tankers. The steel tank storage facilities in Fall River and New Bedford, with an aggregate capacity of about 900,000 barrels, permit of considerable extension as need arises.

The properties are constructed almost entirely of steel, brick and concrete, and are thus subject to minimum depreciation. The business is of a character that requires a minimum labor factor, the total labor costs being estimated at less than 2 per cent. of the gross turnover.

The present capacity and plans of the company permit an annual run-through of at least 6,000,000 bbls. of crude oil to produce about 3,000,000 bbls. of "Navy

A" fuel oil, 1,143,000 bbls. of marine and commercial fuel oil, 400,000 bbls. of Navy gasoline, 455,000 bbls. of commercial gasoline, 235,000 bbls. of kerosene distillates, and 700,000 bbls. of coke or flux.

The New England Oil Corporation has entered into a contract with the United States Government, under which deliveries are now being made, to supply the United States Navy, prior to April 1, 1922, with not less than 3,000,000 bbls. of "Navy A" fuel oil and 376,000 bbls. of Navy gasoline. The United States in turn guarantees transportation facilities to the refinery for 5,000,000 bbls. of crude oil. The New England Oil Corporation has also entered into contracts with the

Standard Oil Co. of New York and with consumers of fuel oil, for the sale of additional products of this refinery and with the Royal Dutch interests and other large producers in Mexico for a supply of crude oil sufficient to cover a substantial portion of the requirements of the refinery.

New England, without coal mines, historically has been dependent upon outside regions for her fuel supplies. The growing utilization for fuel and motive power of petroleum and its products and the establishment of this industry in New England are a notable instance of geographical integration of industry.

New Talc Grinding Capacity in the United States

By Raymond B. Ladoo

Mineral Technologist, Bureau of Mines

THE talc milling capacity in this country is being expanded so rapidly that it becomes a matter of importance to inquire into the probable effects that the additional production to be expected from this increased capacity may have on the industry. From information now available it seems that at least nine companies have recently built, are now building, or contemplate building, increased talc grinding capacity to the extent of about 500 tons per day, or 150,000 tons per year. Of this new capacity, 235 tons per day is already built, though no production resulted from it in 1920; 85 tons is now under construction and nearing completion, while 180 tons is contemplated. In addition to these tonnages definitely accounted for, there are sev-

eral other companies which are considering expansion and several new companies recently incorporated. The accompanying chart shows the domestic production of talc and the total indicated consumption (production plus imports) in short tons since 1910. From this chart it will be noted that the estimated total consumption of our maximum year, 1920, was about 237,000 tons or 790 tons per day. But of this total about 24,000 tons was imported, reducing the domestic production to about 213,000 tons, or about 710 tons per day.

Unless a high protective tariff on talc is enacted, imports will increase rather than decrease. Thus the maximum consuming capacity for domestic talc to date may be taken at about 700 tons per day. However, it cannot be assumed that 1920 conditions will be repeated in the immediate future. The new capacity of 320 tons per day, which may be expected to be in operation this year, would add to our peak production more than 45 per cent., and, with the contemplated 180 tons, more than 70 per cent. The increases over the previous maximum production of about 198,600 tons in 1917 would be respectively 55.5 per cent. and 83 per cent.

The erection of some of the new mills may be justified by the fact that through improved milling methods their product will not be forced to find new markets, but will merely replace that from older but less efficient mills. Also, some addition to grinding capacity is undoubtedly justified by the normal increase in demand and by the abnormal increase of the last few years. However, after making due allowance for these considerations, it seems evident that the great increase cannot be absorbed through our present channels of consumption, and additional construction seems unwise at this time unless definite new markets are first established.

Instead of increasing the plant capacity, a better policy would be to spend available capital in improving mines and mills to produce a better product at a lower cost, to consolidate small inefficient companies into larger and more efficient units, and to pay for research, investigation and publicity which would develop new markets and uses and expand older ones. Regardless of further additions to capacity, it does not seem probable that present plants can run to capacity unless new uses and markets are developed. Despite the record demand for 1920, several long-established mills were unable to run at anywhere near their capacity on account of power shortage, ore shortage, etc. While it is impossible to run all mills at their theoretical capacity, it is evident that present mills when run at even average efficiency would produce far more talc than present markets can absorb. Running mills at a small fraction of capacity is very wasteful and expensive.

This difficulty is not found in the talc industry alone, as is evidenced by the condition of the zinc, asbestos and other industries. The zinc producers through the American Zinc Institute have adopted an aggressive campaign of research and publicity to expand their markets. The asbestos interests have recently formed an association of companies engaged in the mining, jobbing, manufacturing and finishing of asbestos and asbestos goods, known as The Asbestos Industries. The purpose of this organization is to expand the markets and uses of asbestos through investigation, research and large-scale, educational publicity. The Talc and Soapstone Producers' Association can do much to remedy the condition of the industry if it has the proper backing and support, but so far this support seems to have been lacking.

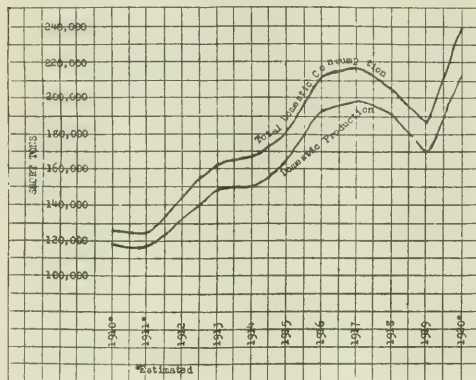


Fig. 1. Production and Consumption (Production plus Imports) in the U. S.

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Personal Items

John W. Leathers, Jr., has resigned his position in the Chicago office of Marden, Orth & Hastings, and has accepted a place with the Falk Co., in Chicago.

* * *

Albert H. Israel, formerly works manager of the American Mustard Co., Inc., Brooklyn, is now general manager of the Mustard Products, Inc., Brooklyn, N.Y.

* * *

E. H. Frantz, formerly with the Duratex Co., of Newark, has recently established himself as a consulting research chemist at 940 North 4th Street, Reading, Pa.

* * *

J. H. Libberton, formerly manager of the Service Bureau, Universal Portland Cement Co., is now with the General Chemical Co., 25 Broad Street, New York.

* * *

Robert B. Harper, chief chemist, People's Gas, Light & Coke Co., Chicago, Ills., is sectional vice-president and chairman of the technical section of the American Gas Association.

* * *

O. E. Ruhoff has resigned from the staff of the French Battery & Carbon Co., of Madison, Wis., and is now associated with the Industrial Research Laboratories of Chicago, Ills.

* * *

G. C. Knickerbocker, formerly chief chemist of the Knickerbocker Portland Cement Co., Hudson, N. Y., is now with the Great Western Portland Cement Co., Mildred, Kans., as chief chemist.

* * *

W. E. Burkhard, formerly chemical engineer with the Perth Amboy Chemical Works, is now chemical engineer with Clark, MacMillan & Riley, consulting engineers, 101 Park Avenue, New York City.

* * *

L. M. Lehr, formerly manager of the chemical department of W. H. & F. Jordan, Jr., is now in charge of the recently opened New York office at 20 Fulton Street, of the Charles McAdam Co., industrial chemicals, Chicago, Ills.

* * *

R. T. Stull and W. M. Weigel, chemists of the Bureau of Mines, represent that organization in its co-operation with the Georgia Central Railroad in a survey of the clay, bauxite, feldspar and graphite deposits in the State of Georgia.

* * *

The board of trustees of the Armour Institute of Technology has announced the appointment of Howard M. Raymond as acting president of that institution, to fill temporarily the vacancy caused by the recent death of Dr. F. W. Gunsaulus.

* * *

Leo B. Forst, for 10 years in charge of the Cincinnati laboratory of the Bureau of Chemistry, is now associated with the United States Food Products Co. and the Kentucky Distilleries Warehouse Co., in New York.

* * *

H. C. Daggett, formerly of the General Chemical Co., is plant superintendent of the Sanborn

Chemical Works, manufacturers of anthraquinone, Putnam, Conn. F. H. Sanborn is president and general manager of the company.

* * *

David T. Schultz has resigned his position as chemist in charge of the analytical laboratories of the Atlantic Refining Company, Philadelphia, Pa., to become chief chemist of the New England Oil Refining Company, Fall River, Mass.

* * *

Andrew H. Green, Jr., vice-president and manager of the Detroit plant of the Solvay Process Co., has been transferred to the head office of the company, at Syracuse, N. Y., where he has charge of all operating departments.

* * *

Dr. Paul E. Klopsteg, who has been connected with the sales and advertising department of Leeds & Northrup Co., Philadelphia, Pa., for several years, has recently accepted a position with the Central Scientific Company, of Chicago, as manager of development and manufacturing.

* * *

The newly elected officers of the Chemical Club of Philadelphia are: J. H. Stutt, of E. I. du Pont de Nemours Co., president; F. S. Havens, of Atlantic Products Corporation, vice-president; W. J. Thorn, of Innis, Speiden & Co., treasurer (re-elected); W. H. Davis, of Harshaw, Fuller & Goodwin Co., secretary.

* * *

Dr. Paul G. Weiler, formerly assistant works engineer with the Duratex Co., Newark, N. J., is in charge of the branch office of Gregg & Co., industrial engineers of Newark, N. J., at San Antonio, Texas, where this organization has transformed the Lone Star brewery of the Anheuser-Busch interests into a cotton textile mill.

* * *

C. F. Graff, president of the American Nitrogen Products Co., of Seattle, says that the nitrite of soda industry has been saved by the action of the War Trade Board in prohibiting nitrite importations excepting under license. According to Mr. Graff the industry was in a fair way to being killed by German goods until this action was taken.

* * *

Changes in the administrative personnel of the Albany Chemical Co., Albany and New York, embrace the addition of B. F. Witbeck, Parker Corning and Niele F. Townner to the board of directors. B. F. Witbeck is the new president and treasurer of the corporation. Dr. Michaelis, who was one of the founders of the company, has been made chairman of the board of directors.

* * *

Professor S. C. Prescott, acting head of the department of Biology and Public Health of the Massachusetts Institute of Technology, announces the beginning of a course in fisheries next fall at that institution. The course will also include some business administration, so that the men taking the course will be equipped to act as managers of companies dealing in these commodities. By substituting other courses for those dealing with marine life, the course may be adapted for the packing industry. Professor Prescott is planning to start for Chicago shortly in order to confer with the packing men there.

Industrial Notes

Colgate & Co., soap-makers and perfumers, Jersey City, N. J., has acquired at public offer for a bid reported to be about \$360,000, the 40-acre tract and 20 buildings of the Indiana State Reformatory at Jeffersonville, Ind. Possession will be had October 1, when the company will transform the structures into a plant to take care of its business in the mid-continent region.

* * *

The Maryland Fiber Products Co., Hagerstown, Md., recently incorporated with a capital of \$150,000, has plans under way for the establishment of a factory to manufacture fiber cases and other fiber specialties. It is headed by Mark H. Landis, manager of the Landis Engineering & Mfg. Co., 225 Ringgold Street, Waynesboro, Pa. Other officials are Richard G. Stevenson and Thomas M. Cunningham, Hagerstown.

* * *

O. S. Sleeper & Co., 706 White Building, Buffalo, N. Y., is a new organization, specializing in chemical engineering equipment, whose members formerly were of the engineering staff of the Buffalo Foundry & Machine Co., Mr. Sleeper, the head of the new concern, having been chief engineer of the Buffalo Foundry & Machine Co. for the past fourteen years. H. E. Newbauer is vice-president, and C. B. Brown secretary and treasurer.

* * *

The Union Carbide & Carbon Co., 30 East 42d Street, New York, manufacturer of carbon electrodes for electric furnaces, welding apparatus, etc., has arranged for a consolidation of its research laboratories at Long Island City. Property, 200x600 feet, has been leased and will be equipped for electrical, mechanical, chemical and physical research work. The different interests to be represented at the new plant will include the Electro Metallurgical Co. and Union Carbide Co. and the Linde Air Products Co., Buffalo; and the Prest-O-Lite Co., Indianapolis.

* * *

The Air Reduction Sales Co., 120 Broadway, New York, has secured control of the National Carbide Corp., of Virginia, with a new plant at Ivanhoe, Va., and beginning May 1 will direct the policy and control the operation and sales of the Carbide Corporation. With the acquisition of this carbide plant the Air Reduction Sales Co. will manufacture and sell within its own organization everything necessary in the use of the oxyacetylene flame. Airco products now include oxygen, acetylene, welding and cutting apparatus and supplies, acetylene generators, carbide, nitrogen and argon.

* * *

The Empire Fuel Co., a lignite development corporation formed by several local companies engaged in lignite mining near Rockdale, Texas, has a capital of \$1,000,000 and the following officials: Walter Miller, president; Adam H. Davidson, vice-president of the Dallas Guaranty Mortgage Co., vice-president; S. J. McFarland, vice-president of the Security National Bank of Dallas, treasurer, and Roy McKee, secretary of the Dallas Guaranty Mortgage Co., secretary. In 1920, 100,000 tons of raw lignite was mined and used locally. While only the raw lignite is sold at present, tests are being made by Arthur D. Little, Inc., on briquetting the fuel and on its chemical treatment to increase its fuel value.

The Hemingway sales department of the Sherwin-Williams Co., in Philadelphia, has been discontinued and will be superseded by a new special products department of the Sherwin-Williams Co. J. W. Purcell will remain in Philadelphia as head of the new department.

* * *

The Doherty Research Co., 60 Wall Street, New York, Robert G. Griswold, director, has been organized to place the supervision and direction of experimental, research and development work of all companies of the Doherty organization under one central head. It has absorbed the patent department of Henry L. Doherty & Co. and the engineering research department of the Empire Companies at Bartlesville, Okla. In addition to supervising the research work of the organization, the Doherty Research Co. will be the patent holding company for patents obtained to cover the inventions of employees of the Doherty organization and will also look after the patent and trade-mark investigation, prosecution and litigation of the Doherty organization.

* * *

Matching the enterprise of the Joseph Campbell Co., Camden, N. J., in acquiring the manufacturing plant at Hammond, Ind., of Reid, Murdock & Co., wholesale grocers, Chicago, Ills., is the absorption by the Van Camp Packing Co., Indianapolis, Ind., of the Louisville Food Products Co., Louisville, Ky., which henceforth will be operated under the name of the Van Camp Packing Co., from its headquarters in Indianapolis. The Van Camp Packing Co., besides its main factory in that city, has branch establishments at Martinsville, Plainfield, Crawfordsville and Elwood, Ind.; Mattoon, Ills., and Watertown, Algoma, Sawyer, Wis.; Adrian, Mich., and Bryan, O. The Louisville Food Products Co. has four factories in Louisville, Ky., its holdings covering about 27 acres. The combined assets of the two companies total about \$10,000,000.

* * *

The Darco Corporation, which is controlled and managed by the Atlas Powder Co., Wilmington, Del., will erect a plant to manufacture a decolorizing agent with properties superior to bone char, to which has been given the name Darco. This material in extensive commercial tests in the sugar, maltose, oil and chemical industries has been proved to be from 25-30 times as efficient as bone char, and to absorb all suspended color-imparting impurities in about as many minutes as it takes hours to do the same with bone char filters. Darco, it is reported, permits the making of white granulated sugar directly at the raw sugar mill, which fact has potentialities of far-reaching economic importance. The Darco Corporation has patented the product in the United States, Cuba, West Indies, Argentine, Brazil, Mexico, Peru, Philippines, Hawaii, etc.

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CHEMICAL AGE

A CONSOLIDATION OF THE CHEMICAL ENGINEER and CHEMICAL AGE

LLOYD LAMBORN, *Editor*

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Some Chemical Engineering Ideals

By Dr. David Wesson

President, American Institute of Chemical Engineers

PAI NTED on the wall of the library of the National Engineering Societies in New York is the following definition: "Engineering—the art of organizing and directing men and controlling the forces and materials of nature for the benefit of the human race."

This definition is a very broad one and seems particularly to define the activities of chemical engineers. It is a definition which arouses pride in our profession for it indicates that the object of our profession is Service—Service for the benefit of our fellow-beings.

A glance through the list of members of our Institute will show that they are engaged in producing thousands of products which go to improve living conditions, and at the same time provide means of earning a livelihood for multitudes. As an example, take the cottonseed oil industry alone. I mention it because it is the one with which I am most familiar. It gives employment in this country to 20,000 factory hands and 5,000 officers and salaried men. This industry is based entirely on chemical engineering applied to the recovery of the oil of a once-despised waste product and its transformation into valuable human food.

Similar results are effected throughout the country in other industries where the chemical engineer has had the opportunity to apply his knowledge. An enumeration of everything which shows the influence of the chemical engineer would embrace almost every field of human activity applied to production.

The selection of Detroit for the Spring meeting of the American Institute of Chemical Engineers serves to show the relation of the chemical engineer to the automobile industry and to emphasize his essential con-

tributions to its marvelous growth. The rubber tires, the steel frame, the wooden bodies held together by glue, the steel bodies, the many kinds of iron and steel in the engine, the anti-friction metals in the bearings, the artificial leather in the top, the glass in the wind-shields, the fuel used in the motor, the lubricating oil, are examples of the many fields covered by chemical engineers.

The first automobiles were built for pleasure, and the industry developed mainly along the line of replacing the horse-drawn carriage. Now we see motor trucks not only displacing the horse, but competing with the railroad in the movement of merchandise. In the same way the Institute started out largely on an excursion, if not a joy-ride basis, but the responsibilities of the world war and the difficult reconstruction period which we are now passing through, have brought home to us all the idea that the Institute fulfills its highest ideals when it is rendering service to the profession and taking its part in national activities.

The automobile might well be taken as a symbol of the Institute. This industry started in a small way, and in twenty years has contributed more than any other single instrument to the social and economic transformation of the world. In the same way our Institute starting modestly thirteen years ago is rapidly growing into a factor of national industrial importance.

A subject of great importance is the education of the future chemical engineers of the country. The great war has shown that the first line of defense in future wars is going to be engineering chemistry which will wield infinitely more deadly weapons than the big guns of our battle ships. Incidentally, were it not for the chemical engineer furnishing explosives, the big guns would be useless.

Our committee on chemical engineering education,



DR. DAVID WESSON

President, American Institute of Chemical Engineers

¹Presidential address, American Institute of Chemical Engineers. Presented June 21, 1921, Ann Arbor, Michigan.

embracing under the chairmanship of Arthur D. Little, Joseph H. James, Ralph H. McKee, Charles L. Reese, Albert W. Smith and James R. Withrow, has studied the courses of chemical engineering education offered by 78 institutions in the United States, with results that point to the imperative need of standardization, which subject, I am sure, will receive the careful consideration of all interested in the subject of chemical engineering education.

Our Committee On Patents has been keeping in close touch with pending legislature, and I am glad to say the influence of the Institute helped materially to eliminate some particularly bad legislation during the past year. New legislation is constantly coming up and the price of sound laws, like liberty, is eternal vigilance.

The subject of licensing engineers has called for considerable attention, and our Institute is well represented on the examining board in New York State. As in the case of Patent Legislation it is of great importance to use our influence for the best interests of our profession and the community.

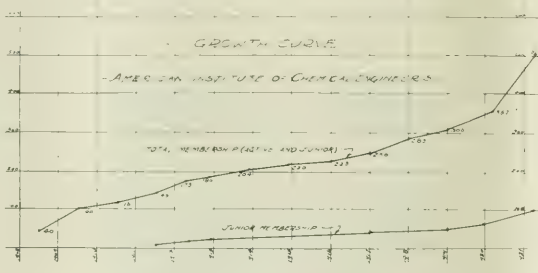
When any legislation pertaining to the Metric System comes up we are well represented, and it is hoped that when this system is finally adopted, that the Institute will not feel ashamed of its part in the matter.

The Institute has put itself on record in favor of a Department of

Public Works, which was to reorganize many of the bureaus of the different departments of the government. This consummation seems about to materialize, though probably under some other name. In the various reorganizations which are to take place in the departments of the government, the Institute should hold itself always ready to aid when called on for expert advice, which will be needed by those on whom the responsibilities of making the changes will fall.

Perhaps one of the greatest sources of usefulness of the Institute is the pleasant social intercourse and fellowship engendered among its members by frequent meetings and excursions. The papers read and the proceedings published, though of great interest and value, are small in comparison with the actual contact of the members with each other. A meeting like the present one is of immense economic value to all of us. It is an inspiration and helps to strengthen the ties which bind us together. The result is that knowing each other we can help each other with our many

problems. Co-operation is the order of the day. We have seen what co-operation has done when used for selfish ends by organized labor. Let us show the benefit of co-operation when exercised for the common good by the American Institute of Chemical Engineers.



American Institute of Chemistry

The Activity of the New Jersey Chemical Society in Initiating One of the Important Functions of This Proposed Organization in the State of New Jersey

By Dr. F. D. Crane

Secretary, New Jersey Chemical Society

IT is with no little satisfaction that I can announce to American chemists the active steps that are being taken under the authority of the New Jersey Chemical Society to promote in this state the movement for the organization of the American Institute of Chemistry.

After a thorough consideration of the replies to our questionnaire printed in *CHEMICAL AGE*, and of other comments upon our plan, our Committee recommended and our Society voted that the movement be continued by our Board of Managers.

This body directed the writer to proceed with the work in the direction of tabulating New Jersey manufacturers and products and New Jersey chemists.

Having these data in hand, we expect to offer to list, without charge, any person, in any branch of the industry, as a Chemist, who considers himself such, and as he wishes to be listed. It is our purpose to make this list complete for New Jersey, so far as we can. At present we can see no reason for excluding any one who wishes to be in this list merely on the ground of location.

The next step will be to offer Registration as a Chemist to any who desire it and who will furnish a reasonable amount of verifiable information about themselves and their work. After investigation, and under proper restrictions, this information will be open to any one interested, and will give, we believe, the first full and impartial information regarding chemists which has been available publicly in this country. The success of this registration will depend on the chemists them-

selves. These Registered Chemists, if they desire to do so, may take steps to set standards of training, education and conduct to which others may, if they wish, conform; this matter will rest with them.

The soundest and best advice which we have received has told us to begin by making this a State matter. It is our purpose to do this, but at present we can not see that we can exclude any one from registration who wishes to take advantage of it. If chemists in other states, or in any national organization wish to take up the matter, they are certainly free to do so.

Our model in organization will be, so far as we can now see, that of the Certified Public Accountants. We want to put chemists on this plane. We want all the suggestions we can get. We want to lay our foundation broad and deep and stable enough to carry any number of chemists in every branch of industry.

Repeated inquiries have been made as to possible "examinations." We will not cross that bridge till we come to it. When we do the Registered Chemists no doubt will handle the matter through our existing facilities, since New Jersey, like many states, has a state college which is entirely competent to meet such problems as they arise in the same broad spirit it has shown in the past.

Meanwhile, we are open to suggestions from any one enough interested to put them on paper. This is an effort to unite in a practical working plan all who believe that the chemist should have a responsible standing and position.

Agricultural Insecticides

Raw Materials and Methods of Manufacture

By R. R. Henderson

Consulting Chemical Engineer

OF the variety of raw materials employed in the insecticide industry, some, as arsenic, are used in large amounts; others only in small quantities, and many merely as incidental aids in the chemical processes and do not appear at all in the finished product, e. g., nitric acid, which is used in oxidizing white arsenic to arsenic acid but which does not appear in the arsenic acid.

Arsenic

The most important raw material is white arsenic. We may roughly estimate that for every pound of combined dry insecticides produced at the present time considerable over one-third of a pound of white arsenic is consumed. The insecticide industry is the largest consumer of arsenic, obtained principally as a by-product of smelting operations, and at one time was allowed to go to waste. Some years ago certain smelters stated that when they could obtain 2 cents a pound for the material it would be worth saving, otherwise they would throw it away. Since that time laws have been enacted restricting the amount of smelter-fume allowed to escape and the collection of crude arsenic in bag houses has become necessary.

Of late years the advanced price of arsenic has made its sale very profitable. A year ago it was selling as high as 17 cents a pound, which was by far the highest price ever obtained. Since that time the price has receded and at present is quoted around 7 cents with every prospect of further recession.

Crude arsenic recovered from the smelters in the form of arsenious oxide is refined by subliming. By this simple process it is possible to obtain a product which is better than 99 per cent. pure. Considerable difference exists in the physical appearance of white arsenic obtained in various parts of the world; also in its specific gravity and the ease with which it reacts with other chemicals. The three principal sources are the United States, Canada and Japan.

Arsenic Acid

In manufacturing arsenates of various kinds it is necessary first to oxidize arsenious oxide to arsenic acid. Many of the insecticide plants purchase this acid in the form of a thick water-white liquid containing 75 per cent. actual arsenic acid. It is shipped in carboys and iron drums.

Previous to its manufacture in quantity in this country it was imported from England, Belgium and Germany. The importation of the liquid arsenic acid was made in lead-lined drums. These drums, however, would last for only one or two shipments. Traces of nitric acid in the arsenic acid always caused more or less corrosion.

In one case a shipment of arsenic acid lay on a New York pier in the warm sun. The sudden explosion of one of the drums caused the death of one man and the injury of others. It was believed that traces of nitric acid in the product attacked the container and built up

a gas pressure within, which, combined with the expansion caused by the heat, was more pressure than the drum could stand. Thereafter certain steamship lines refused to handle arsenic in liquid form. Therefore some of the foreign makers began evaporating the acid to dryness and selling it in the form of granules. However, on account of its hygroscopic nature, unless the dry arsenic acid was packed absolutely air-tight, it would become one solid mass after a few weeks in transit.

During the last few years arsenic acid has been manufactured by several firms in the United States and also quite a few of the insecticide plants are now making it, the process being the oxidation of white arsenic with nitric acid.

When the reaction takes place nitrous fumes are given off, which, combined with air, are passed up through stoneware towers filled with an acid-proof packing down over which water flows, whereby the nitric acid is regenerated for re-use. The bottoms of

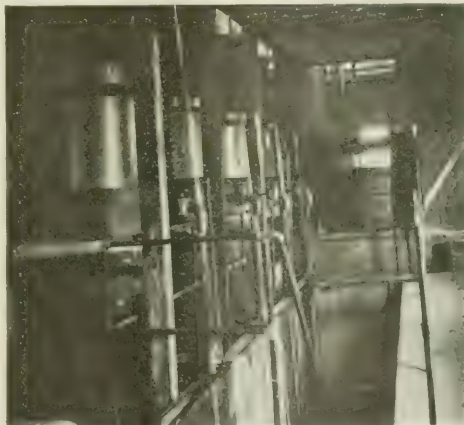


Fig. 1—Nitrotic Absorption Towers in Arsenic Acid Plant. Regenerated Acid Flows from the Outlets.

four such towers are shown in Fig. 1. It is important that all of the white arsenic in the batch is oxidized completely, as its presence in any quantity would tend to cause any insecticide in which it was used to burn the foliage of plants. Equally important is the avoidance of any excess of nitric acid, both for economy of operation and the fact that an excess of nitric acid in arsenic acid tends to produce an arsenate of lead which is heavy and will quickly settle to the bottom of the spray-tank.

At the beginning of the industry in this country foreign methods were followed; and the chemical plant manufacturing arsenic acid, on account of its nitric fumes, arsenic dust and large amount of hand-labor in tending the small units employed, was a very disagreeable place. Many improvements in design, however, have changed all this and there is no reason why an arsenic acid plant cannot now be nearly as clean as the ribbon counter of a department store.

*The preceding article on Agricultural Insecticides was continued in May CHEMICAL AGE and is now devoted to "The Chemical Industry—Importance and Growth of Manufacture." The closing paragraph of the present article will appear in July CHEMICAL AGE and will continue the description of insecticide-manufacturing processes, with illustrations of plant equipment. The final article of the series will appear in August and will cover "Distribution, Present Status of the Industry, Problems to Be Solved."

Larger and larger manufacturing units are being developed. A recent installation for the Standard Chemical Co. designed by the writer contains some of the largest reaction units in the world; each unit being capable of producing nearly fifteen tons of arsenic acid to a batch. The price of arsenic acid is dependent almost entirely on the cost of white arsenic, and most manufacturers are willing to quote prices on the acid for future delivery far in advance, billing the goods at the cost of white arsenic plus a standard manufacturing charge.

Lead

Lead is employed in the insecticide industry chiefly in the form of litharge. Probably 80 per cent. of that used is purchased in this form. Small amounts are used, however, in the form of metallic lead and as lead carbonate.

Metallic lead is used by two firms that convert it into lead acetate preliminary to the manufacture of arsenate of lead; another firm has used it directly in a somewhat complicated process for making arsenate of lead. Some firms have used basic lead carbonate on account of its ease of manipulation in the reaction tanks and the surety of obtaining a high-grade arsenate of lead without great attention. It also has been used as a method of side-stepping the patent situation attending the use of litharge.

Lime

Lime is used both in the form of calcium oxide and the hydrate. It should be a good grade of chemical lime quite free from magnesium and containing little grit.



Fig. 2. Lime-Sulphur Boiling and Storage Tanks

Calcium oxide is used chiefly in the preparation of lime-sulphur solution and calcium arsenate. Some manufacturers, however, prefer the use of the hydrated lime for their calcium arsenate batches.

Sulphur

Sulphur for the manufacture of lime-sulphur solution is purchased in the form of crude lump sulphur and run through crushing rolls to reduce it to about 1/2-inch size. Some amounts of sulphur also are used for combining directly with various insecticides as arsenate of lead, etc., for dry-dusting of fruit trees. For this purpose an exceedingly finely ground sulphur is used.

Tobacco

The tobacco used in the preparation of insecticide compounds is the scraps, stems and sweepings of the

tobacco industry. Some of this is ground very finely and sold directly as a powder for dusting. It also is used as a raw material from which the nicotine is extracted in the form of concentrated nicotine solutions and nicotine sulphate.

Oils

In preparing various emulsions for plant lice and scale insects oils are used, chief among these being various crude petroleum oils and mixtures. Fish oils also are used, being either wholly or partly saponified to assist in forming the emulsion.

Lime-Sulphur Solution Manufacture

Lime-sulphur solution originally was developed and used for dipping sheep. Later its efficiency as a dormant spray for fruit trees was discovered. It is prepared by boiling lime with sulphur and water for a stated period.

Burnt lime first is introduced into a boiling kettle or vat equipped with a stirring device and coils for the introduction of live and closed steam. Water is added to the lime, the sulphur run in and the mass boiled from 45 minutes to one hour. Excessive boiling will cause decomposition and lower the strength of the product. Insufficient boiling does not allow the maximum amount of sulphur to react and wastes some of this raw material.

If the boiling has been carried on properly the batch will consist of an orange-yellow solution testing about 32 1/2-33° Baumé and a greenish-yellow sludge which settles to the bottom of the tank. The clear lime-sulphur solution is filtered from the sludge in a filter-press and is ready for packing. The sludge from the filter-press is washed to remove all soluble sulphur compounds and then thrown away. The wash water is returned for use in making up the next batch.

The price obtained for lime-sulphur solution gradually has fallen until at the present time there is practically no profit in making it. One reason for this is the ease with which farmers or their associations can prepare a home-made article. Being in liquid form and containing around 70 per cent. of water it is a very expensive article to ship any distance and requires an extremely tight package. A barrel that will hold water without leaking will not always hold lime-sulphur solution. It will find and ooze through the smallest crack. It also is a trade custom to allow the return of barrels for credit and in the case of lime-sulphur containers this is bound to cause much dissatisfaction and loss. Nevertheless despite all these drawbacks a few manufacturers still produce this material, and some of them in large quantities. They figure that it is an article which the farmer has to have and if they can sell him that he will purchase from them other insecticides when he needs them on which they can make a profit.

In an attempt to cut down the expense of shipment and produce a material more convenient to handle chemists have tried in many ways to find a method of eliminating the water from the lime-sulphur mixture. The difficulty has been that any ordinary drying process causes decomposition of the material and the resulting dry product cannot be re-dissolved in water.

Through an investigation conducted at the Massachusetts Institute of Technology a few years ago one of our well known insecticide manufacturers found that a certain measure of success could be obtained in drying lime-sulphur providing it was first mixed with a small percentage of some material such as starch or sugar and dried in a vacuum.

The dried product even then was not stable and would decompose rapidly on exposure to the air; an increasing percentage became insoluble with age. Accordingly the firm who had instituted the research did not think it worth while to start the manufacture of this form of dry lime-sulphur. Strange to relate, however, several other manufacturers, finding that lime-sulphur could be dried with partial success by this method, undertook its manufacture and at the present time quite fair amounts of it are being sold. The original investigator still refrains from taking up its production.

Oil Emulsions

These may be prepared in several ways. Soap is dissolved in water and the solution heated. Petroleum oil is then run in and the batch thoroughly mixed and pumped under high pressure through fine spray nozzles. The passage through the spray nozzle causes the formation of a white creamy emulsion.

Another method is first to mix the petroleum with some form of saponifiable oil as fish oil. A caustic soda solution is then run into the batch, while it is rapidly agitated, in sufficient amount to saponify the fish oil. This also forms a white creamy emulsion.

Emulsions also may be prepared by mixing sulphonated oils with petroleum. This forms a miscible oil which on later dilution with water will form an emulsion.

Not all petroleum distillates are toxic to insects. In just what portion of the crude petroleum the toxic principle lies has not been investigated thoroughly. Vickery, in the *Journal of Economic Entomology*, states that "kerosene particularly in California sometimes fails unaccountably to kill scale insects."

The reason for using the oils in the form of an emulsion is that this renders dilution possible. If the concentrated raw oil were used on plants it would injure them. Recently oil emulsions have been prepared by using certain colloidal materials as emulsifiers. These materials assisted by agitation cause the oil to break up into very fine particles in the watery mixture and finally form a very stable emulsion.

Tobacco Extracts

Practically all of the tobacco extract on the market consists of a crude nicotine sulphate. The advantage of the sulphate over the plain nicotine extract lies in its being much less volatile and therefore retaining its effective strength longer when exposed to the air. It also is simpler to prepare from the tobacco refuse, as it can be concentrated readily whereas concentrating the uncombined alkaloid it too readily passes off in the steam.

The common process consists in making a water extract of the tobacco refuse, preferably on the counter-current principle, so that the fresh water comes in contact with the nearly exhausted material. The extract is then neutralized with the proper amount of sulphuric acid and concentrated. Usually the concentration is carried on until the solution contains 40 per cent. of nicotine.

Some time ago an incident occurred in one of our Southern plants manufacturing this article, which, as it did not prove fatal, rather humorously illustrates the mental processes of some of the workmen in our chemical plants. A negro employee in this factory had a toothache. As the pain became increasingly violent during the day he began to cast around for any possible means of alleviating it. Suddenly he remembered that

years before a friend had told him that if one would chew up a little tobacco and place it in the cavity of aching tooth the pain eventually would disappear.

Now, reasoned the employee, if a small chew of tobacco soon would cure a toothache surely a fair amount of the brown liquid in one of the vats which represented the concentrated extract of many pounds of tobacco ought to produce results instantly. He therefore rinsed his mouth with a generous portion and swallowed a little for good measure. It produced instant results alright, but hardly in the manner he expected. A quick call for the doctor and a prompt application of the stomach-pump saved the experiment from a fatal termination.

Paris Green and London Purple

These compounds have been superseded almost entirely by other insecticides such as arsenate of lead and arsenate of calcium.

Paris green is an aceto-arsenite of copper and is prepared from copper sulphate, acetic acid, carbonate of soda and white arsenic. One method is first to add carbonate of soda to a copper sulphate solution and then add sufficient acetic acid to redissolve the precipitate formed. A mixture of white arsenic and carbonate of soda is then added which precipitates the copper-aceto-arsenite. The precipitate is then washed, filtered, dried and ground.

Care should be taken in washing the precipitate to remove most of the sodium sulphate, which is a by-product. Otherwise on drying its presence will so dilute the finished product that a considerable lowering of the total arsenic content may take place.

London purple as originally used was a by-product of the dye industry and consisted principally of arsenite and arsenate of lime.

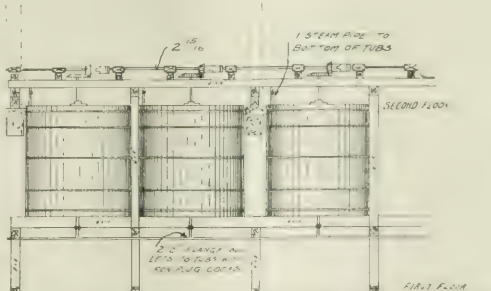


Fig. 3. Mixing Tanks for Precipitating Insecticides

The arsenic acid process for the production of magenta having been replaced by the nitro-benzene and the synthetic formaldehyde processes, there are now no arsenic by-products. Therefore the small amounts of "London purple" still sold are prepared by boiling together lime with white arsenic and any other arsenic-containing material which may be handy around the factory, such as sweepings from the floors, mixtures cleaned from the dust-collecting apparatus which may contain a little of everything, batches of any arsenicals which for any reason have gone wrong, or even refuse obtained from sludge ponds and settling pits.

The chief care necessary is to make sure that the finished mixture contains the guaranteed amount of arsenic and that there is sufficient lime present so that when the product is applied to vegetation the water-soluble arsenic, and consequent burning of foliage, will be at a minimum, which at the very lowest for this material is not safe for many plants.

Census of the Chemical and Allied Industries

THE preliminary statement of the Bureau of the Census, Department of Commerce, of statistics for industries as regards the number of establishments and value of products for the year 1919, with comparative figures for the preceding census year, 1914, permits the segregation of that great group of production activities which we may call the "chemical and allied industries."

The "allied" industries are those that consume the products of the "chemical" industries, which, in turn, may be described as those involving the molecular transformation of matter; which distinction in the intimate inter-relation of chemical manufacture and its common dependence upon chemical control becomes of academic interest only.

The segregation of industries herewith submitted, with figures of growth over the preceding 5-year period, embraces those which require for their operation chemically trained men and which represent the general field of activity of the professional chemist.

The food industries, embracing (1) slaughtering and meat-packing, (2) flour-milling and (3) baking, naturally are pre-eminent, slaughtering and meat-packing alone in the value of its products surpassing the metallurgy of iron and constituting the foremost American manufacturing industry.

These informative statistics are valuable in indicating not only the place and importance of the chemist in the work of production and his indispensable service to American industry, but the vast increase of production capacity of the chemically controlled industries, notwithstanding the higher price levels of 1919 over 1914.

Our total factory production of all industries for 1919 is valued at \$62,500,000,000, or nearly as great as that of the entire world a decade earlier. Our share of the world's output of factory-made goods increased from 30 per cent. in 1914 to 40 per cent. in 1919.

Industry	Number of establishments		Value of products	
	1919	1914	1919	1914
Electroplating.....	516	479	12,213,000	4,773,000
Emery and other abrasive wheels.....	61	49	30,900,000	7,130,000
Enameling.....	74	77	2,645,000	2,160,000
Explosives.....	119	111	92,385,000	41,453,000
Percolators.....	31	.....	40,640,000	.....
Fertilizer.....	599	784	278,610,000	153,196,000
Fire extinguishers, chemical.....	32	27	5,620,000	1,298,000
Fireworks.....	57	41	6,532,000	2,296,000
Flavoring extracts.....	454	424	27,671,000	11,380,000
Flour mill and grain mill products.....	10,714	10,788	2,193,007,000	877,680,000
Food preparations, not elsewhere specified.....	1,998	1,559	662,883,000	219,333,000
Fuel, manufactured.....	11	14	1,974,000	883,000
Galvanizing and other coating processes.....	50	48	14,381,000	8,480,000
Gas, manufactured, illuminating and heating.....	1,020	1,284	328,851,000	220,238,000
Glass.....	371	343	251,834,000	123,085,000
Glucose and starch.....	56	89	186,256,000	52,615,000
Glue, not elsewhere specified	61	57	32,084,000	13,733,000
Gold and silver, reducing and refining, not from the ore.....	87	78	55,483,000	28,588,000
Graphite, ground and refined.....	24	11	2,240,000	1,724,000
Grease and tallow, not including lubricating greases.....	477	369	66,052,000	24,901,000
Ink, printing.....	89	70	26,238,000	13,830,000
Ink, writing.....	61	54	6,434,000	2,784,000
Iron and steel, blast furnaces.....	195	160	794,467,000	317,654,000
Iron and steel, mill works and rolling mills.....	484	427	2,812,775,000	918,665,000
Japanning.....	36	35	771,000	381,000
Leather, tanned, curried, and finished.....	683	741	928,584,000	367,202,000
Lime.....	479	627	37,028,000	18,391,000
Liquors, distilled.....	35	434	33,021,000	206,779,000
Liquors, malt, including cereal beverages.....	728	1,250	379,838,000	442,149,000
Liquors, vinous.....	342	318	17,454,000	16,618,000
Lubricating greases.....	54	77	8,873,000	4,919,000
Malt.....	55	97	39,240,000	48,133,000
Matches.....	21	20	15,874,000	12,556,000
Mineral and soda waters.....	5,112	5,463	130,673,000	58,401,000
Minerals and earths, ground or otherwise treated.....	390	244	43,692,000	10,307,000
Mucilage, paste, and other adhesives, not elsewhere specified.....	123	127	10,931,000	5,695,000
Oil and cake, cottonseed.....	713	882	570,213,000	210,727,000
Oil, essential.....	78	165	5,698,000	2,314,000
Oil, linseed.....	26	25	120,638,000	44,883,000
Oil, not elsewhere specified	278	181	180,431,000	38,040,000
Oilcloth and linoleum, floor	21	18	52,673,000	17,602,000
Oilcloth, enameled.....	11	13	15,437,000	7,996,000
Paper and wood pulp.....	39	17	65,302,000	15,080,000
Oleomargarine.....	692	585	255,636,000	112,409,000
Paints.....	714	718	794,350,000	332,147,000
Patent medicines and compounds.....	2,456	2,908	210,362,000	102,463,000
Perfumery and cosmetics.....	568	592	59,692,000	16,899,000
Petroleum, refining.....	394	176	644,684,000	396,361,000
Pickles, preserves, sauces	712	672	144,302,000	60,915,000
Pottery.....	339	350	74,884,000	36,943,000
Rubber:				
Belting and hose.....	14	18	25,958,000	23,561,000
Foots and shoes.....	24	23	132,188,000	53,822,000
Rubber goods.....	437	391	980,070,000	223,611,000
Salt.....	86	98	37,514,000	14,070,000
Sand and emery paper and cloth.....	12	12	9,204,000	4,228,000
Sand-lime brick.....	33	45	1,709,000	994,000
Sand-lime, structural.....	688	649	3,714,840,000	1,454,495,000
Slaughtering, wholesale, not including meat-packing.....	605	630	281,417,000	197,470,000
Smelting and refining:				
Copper.....	33	37	632,897,000	444,022,000
Lead.....	25	22	192,655,000	171,579,000
Zinc.....	38	29	103,103,000	53,538,000
Metals, not elsewhere specified.....	7	.....	13,996,000	.....
Smelting and refining, not from the ore.....	81	81	50,246,000	39,962,000
Soap.....	352	374	317,967,000	127,942,000
Sugar, beet.....	85	40	149,176,000	62,605,000
Sugar, cane.....	202	181	57,741,000	21,635,000
Sugar, refining, not including beet sugar.....	20	18	730,987,000	289,399,000
Sulphuric, nitric, and mixed acids.....	39	32	31,470,000	15,215,000
Tobacco, chewing.....	365	436	238,820,000	175,281,000
Tobacco, smoking and snuff.....	1,192	1,394	53,166,000	20,660,000
Turpentine and rosin.....	227	215	83,440,000	33,215,000
Varnishes.....	720	618	24,671,000	7,811,000
Vinegar and cider.....	49	48	23,095,000	15,887,000
Wall paper, paper, in paper mills.....	161	167	26,861,000	16,544,000
Wall plaster and composition flooring.....	113	95	31,827,000	9,883,000
Wood distillation.....	88	68	32,521,000	21,065,000
Wood preserving.....	34	24	13,702,000	4,565,000
Wool scouring.....				

Industry	Number of establishments		Value of products	
	1919	1914	1919	1914
Aluminum manufactures.....	84	37	\$69,474,000	\$19,597,000
Ammunition.....	43	32	88,059,000	30,840,000
Asbestos products.....	43	48	18,948,000	2,814,000
Babbit metal and solder.....	128	102	70,781,000	19,180,000
Baking powders and yeast	84	124	40,270,000	22,239,000
Belting, leather.....	172	151	40,939,000	23,036,000
Blacking, stains and dressings.....	220	197	25,279,000	9,882,000
Bluing.....	65	66	2,803,000	1,184,000
Bone carbon and lamp-black.....	36	27	6,194,000	1,464,000
Brass, bronze and copper products.....	1,122	992	487,707,000	162,199,000
Bread and other bakery products.....	25,232	25,963	1,406,145,000	491,893,000
Brick and tile, terra-cotta, and fire-clay products.....	2,439	3,239	211,093,000	135,921,000
Butter.....	5	456	583,216,000	243,379,000
Butter, reworking.....	5	17	2,229,000	5,863,000
Candles.....	18	15	1,864,000	1,731,000
Canning and preserving fish	410	830	77,284,000	31,111,000
Canning and preserving, fruits and vegetables.....	3,069	3,153	492,625,000	149,176,000
Canning and preserving oysters.....	67	65	2,976,000	2,238,000
Cement.....	122	133	171,459,000	101,759,000
Cheese.....	3,530	3,062	143,708,000	51,745,000
Chemicals.....	587	895	423,537,000	158,054,000
Chewing gum.....	62	74	51,240,000	17,169,000
Chocolate and cocoa products, not including confectionery.....	48	36	139,258,000	35,713,000
Cleansers and polishing preparations.....	492	398	26,215,000	9,152,000
Coal-tar products.....	183	.....	158,482,000	.....
Coke, not including gas-house coke.....	253	231	269,879,000	99,275,000
Condensed milk.....	401	190	339,570,000	69,161,000
Confectionery and ice-cream.....	6,624	4,754	637,215,000	209,669,000
Cordials & flavoring sirups	142	142	46,805,000	15,316,000
Creams.....	23	10	6,139,000	1,886,000
Drug grinding.....	31	25	16,925,000	5,080,000
Druggists' preparations.....	529	416	113,153,000	48,010,000
Dyeing and finishing textiles, exclusive of that done in textile mills.....	825	507	332,960,000	100,292,000
Dye-stuffs and extracts—natural.....	140	112	55,962,000	20,620,000

Responsibilities of the Technical School

Inaugural Address on the Occasion of His Installation as President of the Massachusetts Institute of Technology

By Dr. Ernest Fox Nichols

MANY of you who have lately become familiar with Mr. H. G. Wells' interpretation of history will realize new significance in the fact that children are born into a world that is already old. For many thousand years before our generation men were experimenting with Nature, with social, economic, political, and religious ideas and practices. Our civilization to-day is the forward-borne product of this slowly and painfully acquired experience of the race.

The whole educational process, broadly seen, is the problem of putting our young people in touch with the more outstanding results of this age-old accumulation and of giving them exercise in the most direct thought processes by which this experience and knowledge have been acquired; processes by which experience and knowledge may be enlarged and extended.

The education of boy or girl, therefore, consists in bringing them up to the present day, so that they can enter independent life as useful thinkers and doers in the world as it is. Dreams of what the world ought to be are not only stimulating but indispensable to human progress, but each generation must begin building on the world as it finds it.

Expressed otherwise, our educational effort is directed to give a young man of intellectual interests and possibilities the main features of his racial background and especially to acquaint him with the best and most significant things which have been thought and done in the world, so that at maturity all new things which present themselves to him, he can in some measure appraise in their relations to this background.

I know no better measure of a man's real education than the adequacy of his thought and action in whatever actual situations he may find himself, for adequacy of thought and action imply some hold on world experience. Our daily use of the phrase "common sense" has no other meaning.

Vital possession, conscious or unconscious, of this world background enables a man sanely to face and interpret reality. You rarely find such a man seriously occupied in chasing rainbows or fighting windmills. His chief mental characteristics are breadth, balance, sanity. To train such men and women should be the dominant ideal of the educational process. How often and how far, alas! do we fall short of attaining it.

Mr. Chesterton's recent amusing railery at "The ignorance of the educated" would lose none of its charming humor and would gain in truth and pungency if he changed his title to "The ignorance of the half educated." These are the really dangerous men, for they are facile of speech and wholly unaware of their intellectual limitations. By contrast the adequately educated man knows always just where he stands. Ought not an engineer to know enough of philosophy and its uses not to be misled into dogmatizing upon its technical intricacies: and should not a philosopher be taught enough about bridges and dynamos to be satisfied with dwelling on the broad scientific principles they illustrate without venturing to criticize minor details of construction?

Education interpreted as a background builder is far wider than the schools and stretches endlessly from the cradle to the grave. Yet a careful scrutiny of the course of individual development shows that in the lat-

ter half of the period of adolescence, say from eighteen to twenty-five years of age, lie the strategic years of education. It is in this period that wisely directed teaching can do most to integrate and interpret this background, do most to give it unity of form and grouping, color, symmetry and depth. During this formative period no great department of human experience can be safely ignored, if our purpose is to train adequately educated men and women.

The department of human experience and action on which the major emphasis shall fall is a matter wisely left to the individual preference, aptitude, and taste of the student. In schools of technology this emphasis falls naturally on the study of science. But studies in science can be made as narrow as can studies in philosophy and the arts. Narrowness of outlook, always a major defect in our efforts at education, we must strive unceasingly to avoid. All fields of knowledge and experience form a whole, and, in our teaching, their vital interdependence must be most clearly emphasized.

With his characteristic grasp of essentials, President Nicholas Murray Butler has stated these traits of the educated man: (1) Correctness and precision in the use of English; (2) refined and gentle manners; (3) power of reflection; (4) power of growth; (5) sound standards of feeling and appreciation; (6) the ability to do efficiently without nervous agitation. To these I venture to add yet another trait of the *usefully* educated man: Power to marshal the world's experience in at least one field, and to use it effectively for further constructive achievement.

Engineers have, surely, the same broad, educational rights and responsibilities as other professional and non-professional men, yet, amid the growing complexities and perplexities of technical education there has been, and is, a steady and strong temptation to introduce more detailed technical courses at the expense of other background-building studies. This temptation, weighty as are the arguments for yielding to it, must nevertheless be steadily and firmly resisted. The problem of modern technical education is indeed most intricate and difficult, but other solutions must be earnestly sought, for we cannot afford to sacrifice the breadth of a man to create a too narrowly efficient machine.

When President MacLaurin said, "A technical school was not doing its whole duty unless it kept in the closest touch with industry," he spoke the minds of many thoughtful men.

The two outstanding industrial problems to-day are: (1) The more intensive application of scientific knowledge and research to the processes and products of industry; (2) the cultivation of more understanding and wholesome relations between labor and management. Both of these problems may rightly claim attention in any modern scheme of technical education. On each of these questions I wish to speak very briefly.

Scientific Research

Of scientific research there are two more or less distinct types. Both embody the genuine spirit of inquiry; both use the same tools and instruments under

similar laboratory conditions. The essential difference between them is not in method but in aim and intention. In applied science research, the controlling purpose is to reach a definite and predetermined result which can be immediately applied to the material profit, convenience, or comfort of man. In pure science research, the only purpose is the discovery of new knowledge without thought of any material benefit to anybody. The fundamental discoveries from which applied science gets its raw material for useful applications come out of the pure science laboratory. That you cannot apply knowledge you haven't got needs no proving.

Take any familiar application of science you choose, and one, two, or at most three backward steps bring you to the pure science laboratory where the fact or principle employed was first discovered. Sir J. J. Thomson has said in substance, "If you want improvements in industry, you may turn with confidence to applied science. If you want to revolutionize an industry or create a new one, you will do well to search the innermost recesses of the pure science laboratory." The difference between the man of theory and the practical man is one of suggestiveness and scope.

Applied science research in the modern sense is of comparatively recent origin. What we now call pure science is centuries older. At its beginning, therefore, applied science had the accumulated results of centuries of pure science to draw upon, but, due to the brilliantly amazing progress of applied science, that surplus in many fields is nearing exhaustion.

With depleted reserves applied science must soon face one of two alternatives. Either it must descend from its past and present rapid succession of great achievements to a more modest hand-to-mouth existence, reworking old ones and consuming next year whatever pure science, at its present working rate, may discover this; or else the hosts of pure science research must be vastly strengthened, and the volume of their yearly output many times increased.

That some of our more progressive industries already realize the situation is amply proved by the very rapidly increasing amount of pure science research issuing from the research laboratories of our optical, chemical, electrical, and other highly developed industries.

Under these circumstances technical schools owe to modern industry the more intensive cultivation of research with increasing emphasis on pure science. Every possible means should be used to train up more men in pure science, men competent to enter the fruitful and important field of research, to supply the rapidly increasing demand for workers in the fast multiplying laboratories of progressive industry.

In every fruitful co-operation between technical education and industry, our schools should be prepared to give more than they receive and to lead, not follow.

Labor and Management in Industry

Under the present organization of our largest industries the conscious responsibilities of real ownership have become somewhat vague. Industrial ownership to-day is widely diffused and dispersed. Shares of ownership are bought and sold daily by hundreds of thousands. Certificates of ownership are often regarded by their holders more as sources of income than as symbols of responsibility.

As a working plan the rights and duties of ownership are delegated to boards of directors, and the active management of our industries rests in the hands of

employees. Thus the older distinction of employer, meaning owner, and employee, meaning workman, has largely ceased in our largest industrial corporations. All are essentially employees, but of two distinct classes, brain workers and hand workers. The brain workers build up, maintain, and manage the business, and direct the hand workers, as brain directs hands in the individual, with this important and sometimes vaguely realized difference, that the hands in this case are not instruments only but independent thinking, feeling personalities.

The older or traditional attitude toward labor unrest was that the questions involved were purely economic questions. More thoughtful and more widely informed people, and there are many of them, feel that the problem is not so simple, but involves many additional elements, chiefly those which enter into all human relationships.

Purely for the sake of illustration, let us take the case of a not uncommon type of workman who becomes dissatisfied with his job. He feels little or no loyalty to the business nor to the foreman or manager who personifies it. He understands neither the manager's work in relation to production, nor the manager's pay.

There are further enviable differences between the manager's apparent freedom of action, his more comfortable working surroundings and those of the laborer. The laborer fails to realize the economic reasons for these differences. The manager in his sight produces nothing, hence the laborer doubts in his heart the importance of managers and higher officials in general. From his warped outlook, wages would be higher if these men who meddle, but do no real work, were removed from the payroll.

Thus he feels little respect or liking for the management. The manager may also seem lacking in respect for a sour-tempered operative. The motives behind the simplest manifestations of good will may be misconstrued and distrusted. Thus a mutual economic necessity is the only binding material which holds these two together, and each chafes at the bond.

Dissatisfied, the laborer shirks and hates his employment which, in this mood, is without human appeal or interest for him. Furtively shirking, he loses some of his sense of personal dignity and much of his self-respect. Sooner or later, as circumstances favor, he will try to regain a feeling of self-importance by trying with others who are like-minded a concerted conflict with the management in the form of a strike.

If the strike is won, the worker feels his course justified, his conduct approved, his self-esteem in a measure restored. If lost, he returns to his work liking it and his superiors none the better, only to wait sullenly for another trial of strength.

The laborer's indiscriminate and integrated discontent he is likely to attribute to the specter called capitalism. Capitalism is, therefore, his enemy. This monster he attacks in the one spot where he believes its nervous system is centered—its purse. To the agitator of disorganization this mass of accumulated and unsorted discontent is his one great opportunity, and we know he is quick to make the most of it. To the typical proletarian, not the least of the attractions of a world-leveling-down program is the removal of the people he believes respect neither him nor his labor.

This brief view of the tangle of disorders and misconceptions, which may arise in a workingman's mind, shows mental states of by no means infrequent occurrence.

Now the true essence of successful industry is mutual

respect between employee and manager, willing co-operation, a sense of mutual opportunity and responsibility, and a shared personal or institutional loyalty. But these factors are human rather than economic. Economic necessity alone is not only powerless to create them but oftener operates to weaken or destroy them.

Human relationships in industry we have now and always have had, and, whether recognized or not, they have caused quite as much trouble as purely economic conditions, for the state of a laborer's mind, more even than the state of his purse, determines his acts.

No industrial question is of greater importance than human relations in industry, and none is more complex nor baffling. Yet no pains can be spared, or are

being spared, to find remedial measures. Many hopeful schemes for a better human organization of industry have been suggested and are under trial, some fortunately with encouraging promise.

The dominant bearing of this discussion on technical education is this: Our technical schools are training the future brain workers and managers of industry. We may, therefore, well ask ourselves, at this time, if there is anything we can do beyond what we are now doing to train our students to understand more fundamentally and to meet more successfully the gravest of all their future responsibilities, the organization and management of men. A responsibility which they and we owe, not industry alone, but the whole economic, social, and political stability of the nation.

Industrial Alcohol and Prohibition Enforcement

By Martin H. Ittner, Ph. D.

Chief Chemist, Colgate & Co., Chairman Committee on Industrial Alcohol of the American Chemical Society

AT the spring meeting of the American Chemical Society in Rochester Dr. Raymond F. Bacon called attention of the society to the danger threatening the industries of the country if prohibition enforcement legislation is allowed to become enacted without properly providing for the unhampered use of industrial alcohol. A committee on industrial alcohol was appointed to study the subject and represent the society, if need be, before legislative bodies, on matters pertaining to alcohol, on which there was practically a unanimity of opinion within the society.

Bill H.R. 5033, which was recently introduced in Congress to amend the National Prohibition Act, contains features which are unquestionably seriously objectionable to many industries, and the Committee on Industrial Alcohol requested a hearing before the Committee of the Judiciary of the House of Representatives with reference to this bill. This request was finally granted and the Alcohol Committee presented the resolutions of the American Chemical Society on industrial alcohol and a few specific suggestions towards the modification of some of the more objectionable provisions in bill H.R. 5033.

The resolutions of the American Chemical Society which were presented are as follows:

Whereas the use of alcohol in many important industries is absolutely necessary, not only to the continuance of such industries, but also for the manufacture of articles needed by other industries, and even for the production of articles necessary to the protection of, and sustenance of life itself, and

Whereas it is the policy expressed in the National Prohibition Act to encourage the use of industrial alcohol for non-beverage purposes, such as the manufacture of thousands of necessary medicinals, and countless dyes, chemicals and perfumes, and for the production of heat, light and power.

Be it resolved: That the American Chemical Society advises, and most strongly urges, for the national welfare, that all legislation for the enforcement of prohibition be so clearly drawn as not to restrict the activities of legitimate industries which must have industrial alcohol, and that all such legislation be so drawn as to provide in specific sections for the encouragement of the proper use of alcohol in the industries.

The ostensible purpose of Bill H.R. 5033 is to control and prohibit the use of beer and light wines for medicinal purposes, but instead of confining itself to

this, as it might have done, it does not even mention beer, but goes on to limit the supply and use of alcohol. It would not allow any pure alcohol to some of the important industries unless the manufacturer, in each case, could clearly establish to the satisfaction of the Commissioner that it would substantially interfere with his manufacture if he used a medicated or compounded alcohol. The burden of proof is put on the manufacturer. He is denied the alcohol at the outset and he may get it if he is lucky enough to convince the Commissioner. If a manufacturer makes a hundred different articles with the use of alcohol, and some of them make more than that, it will be necessary, in the case of each article, to present a separate argument or the use of pure alcohol will be denied for the manufacture of that article. Respectable, long-established manufacturers even are now subject to frequent and unnecessary delays in their supply of alcohol. This new bill if enacted as introduced would bring about an intolerable condition.

After making it obligatory to "medicate or compound" alcohol, to use the language of the bill, or to denature it in plain English, a "joker" is introduced which reads, "Liquor, including alcohol, so medicated or compounded, shall not be exempted from any tax to which liquor is subject," thereby greatly restricting the use of tax-free denatured alcohol in some of the important industries.

The first glaring defect in the bill, as introduced, to which the Committee on Industrial Alcohol called attention was the power conferred on the Commissioner to restrict the supply and uses of alcohol. In the first part of section 2 the bill apparently permits the manufacture of alcohol without restriction as to quantity, but further along in the same section the Commissioner is told that he *shall* limit the supply and use of all liquors, *not* excluding alcohol. If he is directed to limit the supply of alcohol he must necessarily restrict manufacture. He is directed to limit the supply "to the actual needs for non-beverage uses. No Commissioner can know the actual needs and he is almost sure to restrict the supply of alcohol so that it will be insufficient.

The committee proposed an amendment by introducing the words "save alcohol" after "all liquors," line 11, page 2, section 2, so that it would read as amended "The Commissioner shall limit the supply and use of all liquors, save alcohol, to the actual needs for non-beverage uses, etc." It ought to be perfectly evident that

the Commissioner should not be allowed to restrict the supply and use of alcohol. For instance, he should not be permitted to restrict the supply of denatured alcohol, but if he limited the supply of pure alcohol in accord with his guess as to the actual needs, he would thereby restrict the supply of denatured alcohol; for you cannot have an adequate supply of denatured alcohol if you limit the supply of pure alcohol, as denatured alcohol is made from pure alcohol. The supply and uses of pure alcohol as such for industrial purposes should not be subject to the absolute control of one man.

Section 3 of the bill contains even more objectionable blows at industry. As I have already explained the bill seeks to force manufacturers to use "medicated or compounded alcohol," or in plain English *denatured* alcohol, in the manufacture of all articles, and then after this thrust at industry gives the bayonet a final vicious twist by providing that "alcohol, so medicated or compounded shall not be exempted from any tax to which liquor is subject."

To meet these objectionable parts of the bill, the Committee on Industrial Alcohol offered an amendment to section 3, cutting out the most objectionable parts and adding an amendment that would not only encourage the proper use of alcohol in the industries, but would also tend to prevent much of the diversion of alcohol to unlawful purposes. Section 3 with the amendment proposed would read:

"No other intoxicating liquor than alcohol shall be used in the manufacture of any article enumerated in subdivisions b, c, d and e of section 4, title 2, of the National Prohibition Act unless it shall clearly appear to the satisfaction of the Commissioner that without considering potability the use of some other intoxicating liquor than alcohol is essential as a component part of such article; and, in furtherance of the provisions of title 3 of the National Prohibition Act, tax free alcohol suitably and lawfully denatured may, under regulations, be used in the manufacture of any such article."

The committee after careful consideration decided they could not take any other grounds. If a manufacturer in legitimate business, and we are not considering any other at present, finds that he must have pure alcohol in his work, let him have it under suitable regulations and he will pay the tax that is due on pure alcohol. If he can gradually find suitable denaturants so that in the manufacture of some of his articles he can use alcohol denatured in one way or another, but all unfit for use for beverage purposes, he should then be allowed to use such alcohol tax free. The government should not only not hinder him, but should cooperate with the manufacturer in finding new opportunities for the use of denatured alcohols. Each article so made which was previously made with tax paid alcohol lessens the possibility of alcohol being diverted to beverage purposes. There is no more reason why denatured alcohols used under regulation should be taxed than that coal should be taxed, and there is no reason why any legitimate industry should be denied the use of tax free denatured alcohol.

The Committee on Industrial Alcohol looks upon all of section 4 of H.R. 5033 as unnecessary and objectionable and requested that it be stricken out entirely. This section provides nothing essential to prohibition enforcement and is unnecessarily obstructive. It provides a delay of not less than twenty days to any permit to sell and liquor, including alcohol, to manufacture alcohol, or to manufacture articles from alcohol such as medicines and the like. It requires the public posting of the fact at one's place of business so that any fanatic

may become informed thereof, and then provides a means whereby any fanatic may hold up such a permit and even force a man to go to court to get what the government ought to aid him in getting at the outset. The provision referred to is as follows:

"Any Federal or State officer or any person authorized thereto by any such officer may oppose any such application." It is not unreasonable to suppose that *somewhere* there might be found an overzealous State officer who would come under the designation of "any State officer," and it is not outside the range of possibility to assume that such a State officer might authorize all his zealous friends to oppose alcohol permits, these zealots answering the description of "any person authorized thereto by any such officer," thereby giving them the authority of law to "oppose any such application" for alcohol.

With respect to the other sections of the bill we made no recommendations, but our silence is non-committal.

I cannot refrain from giving my impressions with regard to the hearing before the Committee of the Judiciary. At first, it was not at all certain that we would get a hearing, and the chairman evinced a desire from the start to hear as little as possible against the bill. His frequent remarks tended to divert the testimony of the speaker so that he was forced involuntarily from his intended line of argument. I wish to add that some of the members of the committee impressed one as being both intelligent and fair, but it is doubtful whether many of them realize the injury that legislation of this kind would do industry.

The future prosperity of the country hangs in the balance as much now as it did during war; more perhaps, for then with an outside objective we presented a united front and worked together, but now, with war out of the way, we are already beginning to forget the necessities of yesterday, unmindful of what the morrow will bring forth. In war time we were absolutely dependent upon industrial alcohol and on our industries. The same is just as true in times of peace, and we are courting disaster when we encourage obstructive legislation.

A year and a half ago all manufacture was going full speed. Now many lines of business are in a bad slump. Though economic conditions like foreign exchange and war inflated prices, not the least of which is labor, are responsible for much of the business depression, a greater factor is the uncertainty that we have to face in legislative matters. With Congress continuously mindful of the needs of American industries we cannot help but prosper. We have faith that they see the need of adequate protection against attacks from without, but let us hope they also will protect us from the dangers that arise within like those in H.R. 5033.

Wallace W. Boone has resigned as metallurgist and assistant head chemist, Peters Cartridge Co., King's Mills, Ohio, to accept the professorship of metallurgy, University of Cincinnati.

* * *

Clarence J. West, formerly of Arthur D. Little, Inc., has been appointed managing editor of "Critical Tables of Physical and Chemical Constants," supervision of which is in the hands of the National Research Council. This work, which is to be a critical revision and extension of the well-known Landolt-Bornstein Tabellen, has been assigned to American chemists by the International Research Council as a part of a general program to make available to the English reading world the scientific facts, previously available only in the German language.

Historical Aspects of the Manufacture of High-Purity Crystalline Anhydrous Dextrose

By Chr. E. G. Porst

Director, Research Laboratory, Corn Products Refining Company

ABOUT ten years ago we celebrated the 100th anniversary of Kirchoff's discovery of a saccharine substance manufactured from starch, prepared in the form of a syrup and also in a crystalline form. However, it took several years before the French chemist, Saussure, gave a scientific explanation of the process of converting starch into a sugar with sulphuric acid as a catalyzer. This sugar was identical with the sugar found in grapes and other sweet fruits. It was named Glucose (derived from the Greek word *glukus* sweet) and since 1830 this term was generally used.

I shall not go deeply into the discussion of the first year's development of the glucose industry, but simply refer to the large number of publications in miscellaneous scientific periodicals during the years 1911 and 1912.*

Kirchoff in 1812 was awarded a yearly pension of 500 rubles for life, and decorated with the order of St. Anne, Second Class, by the Russian Emperor. As his invention was made when Napoleon Bonaparte had placed an embargo on all colonial products with the object of destroying English trade with continental Europe, a number of small factories for manufacturing glucose sprang up, especially in France and Germany, due to the exclusion of cane sugar. The price of the sugar made from starch, however, was rather high; the French manufacturer Thorin claimed that the manufacturing cost of one (1) pound was 50 centimes. As it was manufactured chiefly from potato starch it was sold under names such as "Potato Sugar," "Potato Syrup," etc.

There was an ever-increasing demand for this product in the manufacture of sweetmeats, preserves, chocolate, and especially for the wine industry. Louis Gall started its use in the manufacture of wine; his process called "Gallizing," which is still in use, is named after him.

It is interesting to see that the German beer manufacturers in 1818 brewed and sold a beer named "Potato Beer." This was manufactured from a wort, prepared with the addition of a large amount of "Potato Syrup" or "Potato Sugar" to the regular malt brew.

For some years, however, there was a slump in the manufacture of saccharine products from starch, due to the ever-increasing beet-sugar industry. But new uses, especially in the manufacture of candies, were found, and from the year 1870 a great industry developed, especially in Germany. The products sold were exclusively in a syrup or in a solid form, manufactured from high-purity syrup which was allowed to crystallize.

Kirchoff in his first experimental work manufactured a pure grade of the sugar by crystallization, removing the mother liquor by pressing between cloths and recrystallizing the purified crystals. But such procedure

was abandoned, until later taken up again by American manufacturers.

The manufacture of "starch" syrups and sugars in the U. S. A. can be traced back to 1830, at which time a patent was granted to Amable Brozier, Philadelphia, Pa., on the saccharification of maize, rice, and other grains. The patentee, however, never carried out the process on a large scale, but left this to a chemist by the name S. Guthrie, who worked in connection with a Capt. Potter. In their home town, Sackett Harbor, they built a small plant in which they were able to produce 30 gallons of syrup daily from potato starch. The *Journal of Science*, 1832, gives a full description of the process in which it is very interesting to note that the conversion of the starch lasted 6 hours under 5 pounds pressure in a closed wooden converter. (Kirchoff's conversion under natural pressure lasted 36 hours). No industry developed from this experimental work.

During the Civil War a heavy internal revenue was placed on distilled spirits. Therefore, the vinegar manufacturers using the quick process were hurt badly by this tax.

A vinegar manufacturing concern, Fox and Williams, in Buffalo, consulted George Hatley, Professor of Chemistry at the Buffalo Medical College. Under his advice they bought corn starch from the Gilbert Starch Works, Black Rock, N. Y., converting it into a corn sugar. Since Guthrie and Potter's experiments the manufacture of corn starch had developed to a large extent, and it had been customary to term conversion products of corn starch, as "corn sugar" and "corn syrup." (It was Thomas Kingsford who, in 1848, started the first starch works in Oswego, N. Y.) Fox & Williams fermented the corn sugar into high wine to use in the manufacture of vinegar, and at the same time they also sold the sugar to other vinegar manufacturers and brewers.

The sugars made thus far were not chemically pure sugars. They were solidified dextrose solutions containing the mother liquor in which were dissolved mineral matters, dextrine and other impurities.

In the year 1880, a chemist prominent in the corn products industry, Dr. Arno Behr, took out a patent for the manufacture of anhydrous sugar (anhydrous dextrose). His invention led to the building the plant of the Chicago Sugar Refining Company, which was erected at a cost of \$1,250,000 for the manufacture of "anhydrous sugar" alone. It was erected in 1882, but during the year 1883 it was converted into a plant for the general manufacture of corn products, as it was found that the market was not developed enough for "anhydrous sugar" which seldom reached a purity higher than 98. Dr. Behr prepared his anhydrous sugar in the following way:

A sugar solution of proper density was allowed to crystallize in specially constructed cast-iron forms at a temperature favorable to the crystallization of the anhydrous form of dextrose crystals (alpha dextrose). After proper curing, the cast-iron forms were placed in a centrifugal and the mother liquor eliminated by spinning. This process of centrifuging of already

*The Century of Glucose and the Early History of Starch. E. Hirstein, *Jour. of Ind. & Eng. Chem.* 1911, p. 15. *Versammlung des Vereins der Deutschen Zuckerzucker- und Sirup-Industrie*, Berlin Am. C. De. 1911, Band 15, Parow, *Chem. Zeit.*, 1911, p. 1386. Presented at the 10th meeting, American Chemical Society, April 1911.

solidified sugar was afterwards abandoned by the American corn products industry, as it was costly and wasteful. It was superseded by the pressing process, which in the meantime had been developed to perfection by Charles Ebert, at that time superintendent of one of the factories belonging to the Corn Products Refining Company. The finished sugar was sold under the trade name "Cerelese."

During the year 1911 I had an opportunity to study the development of the entire industry of the manufacture of dextrose. It appeared to me that modern centrifugal machinery should be able to separate dextrose crystals from a massecuite of proper gravity and grown under proper conditions. The apparatus which was available for this purpose was not suitable. It consisted of an earthenware crock, equipped with a wooden propeller for stirring the massecuite during the crystallization, and a hand centrifugal. The basket of the latter I lined with a cotton-duck cloth, and afterwards with copper screens representing various meshes. There was available a small vacuum dryer for curing the finished crystals.

Numerous experiments, more or less successful, were carried out. We succeeded with proper handling in making small amounts of white anhydrous dextrose of high purity on a laboratory scale. A sufficient quantity was made to supply certain laboratories and hospitals with a product which was almost 100 per cent. pure.

During the summer of 1915, I visited the Bureau of Standards in Washington, and was very cordially received by F. Bates and Dr. R. F. Jackson of the Sugar Laboratory, and was given detailed information regarding the work which was being carried on in the manufacture of chemically pure dextrose. Although the ultimate results I desired were different from Dr. Jackson's and although I was using different methods, his scientific work* and advice have been of great assistance ever since in producing a dextrose of high purity.

About the same time the Corn Products Refining Company at Edgewater, N. Y., changed superintendents, and for a few years it was my privilege to cooperate with Charles Ebert, who, for many years, had been connected with the industry. He took great interest in the work and gave all possible help and advice. Mr. Ebert's services were invaluable in promoting the work.

During this period we were assisted by a Danish sugar chemist, C. C. Winther. Through his help there was installed a large crystallizer, centrifugal and drying apparatus—and for the first time a pure dextrose of white color was prepared on a manufacturing scale.

In June, 1919, through the courtesy of the Bureau of Standards, W. B. Newkirk, an associate chemist from the Sugar Laboratory, visited our experimental plant to supervise needed experimental work in the manufacture of dextrose. He had had a varied training in the beet sugar industry and was a skilled technician in the art of boiling and graining sugar. It was demonstrated that it was possible to produce commercial white dextrose of over 99 purity from darkly colored solutions. Specifications were then prepared from Mr. Newkirk's suggestions for modern experimental equipment, such as it used in the manufacture of sucrose. This was ordered and installed at our Edgewater plant with satisfactory results. In 1920 Mr. Newkirk entered the employ of the Corn Products Refining Company and assisted in the establishing of a plant which

would produce a white crystalline anhydrous dextrose on a large manufacturing scale.

During the last years of experimental work the Corn Products Refining Company has produced several several thousand pounds of chemically pure dextrose. Based on information which had been received during these years from various physicians who had had an opportunity to use dextrose, a series of hospital investigations and feeding experiments were undertaken. This work was under the supervision of Dr. Wm. H. Porter, who, for 27 years, was Dean at the Post Graduate Hospital of New York, and Edwin F. Bowers, M. D., of the research and editorial department of the E. W. Hellwig Company. Dr. Wm. H. Gies, professor of physiology, of the College of Physicians and Surgeons, and a number of leading physicians and pediatrics connected with some of our prominent hospitals cooperated in this work. The results of these interesting investigations are given in Dr. Porter's lectures published in miscellaneous scientific medical periodicals. The results clearly show the therapeutic value of dextrose of high purity.

I take this opportunity to extend my sincerest thanks to the officials of the Corn Products Refining Company, and desire especially to address my thanks to the President, E. T. Belford, and the General Manager, G. M. Moffett, who have exhibited towards my experiments an always increasing interest, and who have supplied the funds necessary to undertake this important and costly research. It is hoped that there can be presented at the next meeting of this society technical data bearing on the details of the manufacture of high purity dextrose.

The Bureau of Standards has found that pure dextrose or glucose can be crystallized from its water solution and separated from the impurities by centrifugal machines in much the same manner as cane sugar. In controlling this crystallization a knowledge of the solubilities of the pure substance in water is of fundamental importance. These solubilities have been determined at temperatures extending from 0°C to 90°C.

At all temperatures below 50°C the substance crystallizes with one molecule of water of crystallization, i. e., 9% water combined with the crystals, while above 50°C the substance is anhydrous. Dextrose is much less soluble than cane sugar, and thus lends itself readily to this new process of crystallization. The solubilities are: At 23°C, 49.37%; at 30°C, 54.68%; at 50°C, 71.06%; at 55°C, 73.08%; at 80°C, 81.46%, and at 90°C, 85.0%.

* * *

The Textile Color Card Association of the United States, Inc., has just released to the trade the 1921 fall season color card containing seventy-eight colors, sixty-six of which are portrayed in silk and twelve in wool. This card is America's forecast for fashionable colors for the coming autumn and winter season and includes the latest creations in all branches of industry.

* * *

The expedition financed by the H. K. Mulford Co., pharmaceutical manufacturers, Philadelphia, Pa., and headed by Dr. H. H. Rusby, dean of the school of pharmacy of Columbia University, sailed on June 1 for Antofagasta, Chile, from which place it will travel via the Guggenheim mining properties to La Paz, Bolivia, where, passing through unexplored regions, it will cross the Andes at an elevation of 19,000 feet. The chief object is the collection of herbs and plants likely to be of use in medicine.

* Scientific Paper of the Bureau of Standards No. 293, The Saccharimetric Normal Weight and Specific Rotation of Dextrose. R. F. Jackson.

The Emergency Tariff Act

An Explanation of Essential Provisions of the Current Tariff Legislation

By John R. Rafter

Former Special Attorney, Customs Division, Department of Justice

NOW that the so-called emergency tariff bill has become law, it is surprising to note the misinformation which exists concerning it. It is not only being continually confused with other tariff proposals which either have been abandoned by Congress as undesirable or are still under consideration, but, even among those who are careful to distinguish the new law from other intended measures, there is much misunderstanding about it.

It is not the purpose of this statement, however, to attempt an interpretation of the law which will bring out the exact shade of meaning of all its various provisions, but merely to dispel some of the mists which have gathered about its most elementary points and have apparently obscured its meaning.

In the first place, it is unfortunate that the law has become popularly known as the Emergency Tariff Act, because that name has given rise to the impression that the act is of a temporary nature only. As a matter of fact the law consists of five separate and distinct parts, only two of which are temporary. The five parts are: Title I—Emergency Tariff; Title II—Anti-dumping; Title III—Assessment of Ad Valorem Duties; Title IV—General Provisions; Title V—Dyes and Chemicals.

Title I—Emergency Tariff

The first part provides new rates of duty for all of the articles which it mentions. The new duties, except on manufactures of cotton and manufactures of wool, take the place of the former rates or free list provision for the same kind of articles in the Tariff Act of 1913. In the case of manufactures of cotton and manufactures of wool, however, the new duties under this law do not take the place of the duties provided for by the Tariff Act of 1913, but are to be added to them.

This part of the law will be effective for six months only, beginning May 28, 1921, and will apply to merchandise withdrawn from bonded warehouse on or after that date, as well as to merchandise entered for consumption directly.

Title II—Anti-Dumping

The second part is permanent. It is intended to protect American industries from the "dumping" of foreign products into this country.

As popularly understood, "dumping" means selling goods to a foreign country cheaper than such goods are sold at home—the purpose being to capture the foreign market. It implies, generally speaking, sales made at little or no profit or even at a loss, and is usually associated with the disposition of surplus stocks of goods. Under the law mentioned, however, dumping is not necessarily so regarded; but the test is merely a lower price to this country than to other countries and the injury or likelihood of injury to an American industry because of such lower price.

In other words, under the law as written, if the Government learns that an importer in this country is buying goods from abroad at less than the foreign seller is supplying the same kind of goods to his home trade or to other countries and that, as a result of such practice, an American industry is being injured or is

likely to be injured, the importer will not only have to pay the full amount of duties otherwise provided for, but must pay in addition a special dumping duty equal to the difference between his own purchase price and the foreign market value.

An Example

To illustrate: Let us assume that an importer has brought into this country wool cloth from England at a cost of 10 shillings per yard, and that at the same time the same kind of cloth was being sold by the English manufacturer to his home trade or to countries other than the United States at 12 shillings per yard. The importer will not only pay duty on a value of 12 shillings per yard and possibly so-called penalties, if he fails to declare that value when entering his goods, but he will also be compelled to pay a special dumping duty equal to the difference between his own price and the foreign value, namely, 2 shillings, for every yard imported. Such payments, of course, will depend on a finding by the Government not only that the difference in price exists, but also that as a result American industry is being injured.

It would be well for importers to remember that the anti-dumping feature of this law is not confined to merchandise which is dutiable at ad valorem rates, but is equally applicable to special duty goods and merchandise admitted free of duty.

In the case of goods which are consigned to an importer in the United States, or which are sold to an importer who is in any way connected with the foreign seller, the Government, in order to determine whether or not the goods are being dumped, will not merely make the comparison between the foreign value and the importer's invoice price, but will ascertain the price at which the importer has sold or will eventually sell such goods in this country. After deducting from the sales price in this country all costs, duties and other charges incurred in bringing the goods from the foreign country into the United States, and the amount of selling expenses incurred and commission, if any, paid on the sales in the United States, it will make the comparison between the net result and the foreign value.

Indeed, an importer who receives goods on consignment is not, for the purposes of this law, regarded as an importer at all, but rather as the exporter of such goods. And this is equally true of an importer who purchases his goods, but who owns or controls, directly or indirectly, any interest in the business of the foreign producer or seller, or whose business in turn is owned or controlled in any degree by the foreign producer or seller.

If the imported goods are made specially for the United States, and are not sold elsewhere, and consequently have no foreign market value, the Government, to determine whether or not they are being dumped, will then take their cost production, including not only material and labor costs and general expenses, but a theoretical profit as well equal to what would have been realized if the goods had been sold elsewhere. A comparison of such cost will then be made with the importer's purchase price, or, in the case of consigned

goods, with the net amount remitted to the foreign exporter from the proceeds of the sale in this country.

Dumping and Undervaluation Distinguished

Inasmuch as "dumping" is to be regarded as the selling of goods to this country at less than in the foreign seller's home market or to other countries, it must not be confused with undervaluation, which means the declaration on entry of a value lower than the foreign market value. To make the distinction clear, dumping refers to the act of the exporter in selling at too low a price, while undervaluation relates to the act of the importer in entering at too low a value.

The importer who has bought his goods at less than their foreign market value, may avoid undervaluation by adding to his purchase price on entry of his goods an amount sufficient to equal their foreign value. Such additions, however, will not protect him against the dumping duty referred to, which will have to be paid regardless of his declaration on entry. As a matter of fact, the importer who is careful to declare the true foreign value of his goods will be placed at a disadvantage under the new law, as compared with one who is less scrupulous in that respect. If on entry he declares a value which is higher than his own purchase price, his very declaration may tend to prove that his goods are being dumped there; for it will at least call the Government's attention to the fact that his price is lower than the foreign value. And, if the Government concludes that domestic interests are suffering thereby, he will be compelled to pay the special dumping duty.

It is hoped and believed, however, that this drastic provision of the law will not be harshly applied, but will be invoked only after mature consideration of its effects, not only on the domestic interests involved, but on the importer's interests as well.

Title III—Assessment of Ad Valorem Duties

The third part of the law is also permanent, and is probably the most important section of all.

Until the passage of this law ad valorem duties were payable on the foreign market value of imported merchandise plus the cost of putting the goods in a packed condition ready for shipment to the United States. For more than a generation past foreign market value has been construed to mean the value for domestic consumption in the country of exportation.

Of late years it has been quite customary for foreign sellers to charge more for their goods when sold to this country than when sold for domestic use in their own countries. This practice, of course, which still continues to some extent, was directly attributable to the depreciation in the value of almost all foreign currencies, as compared with our money. In other words, the foreigners, whose currencies have been so affected, were quick to realize that from our standpoint their moneys were so cheap that we could well afford to pay higher prices for their goods than their customers at home. In a word they have been profiteering at our expense for some time past.

As a result of this condition, the importers of such goods, who, it will be remembered, are enjoined by law to declare the true foreign value, which until a few days ago meant the value for domestic consumption in the country of exportation, were quite willing to comply with the law by deducting from their own purchase prices amounts sufficient to equal such foreign values. These deductions, of course, meant that substantially smaller amounts of duty were paid by the importers than if they had paid on their own purchase prices; and, consequently, involved a considerable loss of revenue for the Government.

Title III of the new law, however, meets that situation effectively and completely by simply providing that in no case shall ad valorem duties be assessed on less than the value at which the imported merchandise is sold for exportation to the United States. As matters now stand, therefore, importers must pay duty either on the value of their merchandise for domestic consumption in the country of exportation or on its value for exportation to the United States, whichever is the higher.

Title IV—General Provisions

The fourth part of the law, which is also permanent, relates principally to the conversion values of foreign currencies, and the inspection of importers' and foreign sellers' books of account, etc., by Government officers.

With regard to the conversion of currency: It is obviously necessary for the Government in the case of all imported merchandise, which is dutiable ad valorem and which is bought or invoiced in a foreign currency, to know not only the proper value of the merchandise expressed in terms of that currency, but also the value of the currency itself. Otherwise, it would be impossible to convert the foreign value into dollars for the purpose of calculating the amount of duties.

This question has been of vital importance of late years, owing to the great depreciation and constant fluctuation in the values of almost all foreign currencies. Heretofore the Government has relied on the United States consuls in the foreign countries to certify the values of the foreign currency in which the invoice of imported goods was made out. That method of acquiring such information proved unsatisfactory, however, and has now been changed. Under Title IV of the new law, foreign currency values will hereafter be ascertained from the Federal Reserve Bank of New York; and the value which the Government will follow will be the buying rate for cable transfers in the New York market at noon on the day the imported goods were exported to the United States.

Under this title of the new law, too, Congress has seen to it that the investigating officers of our Government, whose duty it is to ascertain the foreign values of imports and other facts essential to the administration of the customs, shall not be denied access to importers' and foreign sellers' books of account, etc., when it is necessary to inspect them. If either an importer or his foreign seller now refuses permission to make such an examination, the law provides that the importation of merchandise from the same importer or by the same importer shall be prohibited as long as the refusal on the part of either continues.

Not only that, but there is also a provision for withholding delivery of merchandise coming from such exporter or intended for such importer until the Government's request has been acceded to. If the refusal continues for one year, the merchandise, unless previously exported, will be sold by the Government at public auction.

Title V—Dyes and Chemicals

The fifth part of the law merely transfers jurisdiction over import licenses of dyestuffs and chemicals from the War Trade Board to the Treasury Department, and provides for a continuation of the licensing system for three months only, beginning May 28, 1921.

Dr. William Crocker, who was until recently agricultural adviser of the Gypsum Industries Association, has been elected director of the Thompson Institute for Plant Research, Yonkers, N. Y.

The Chemist in the Packing and Allied Industries

By Dr. Charles H. MacDowell

President, Armour Fertilizer Company

THE corn belt and range cheaply could grow a surplus of meat foods; the industrial East needed those foods. How best could the two sections get together? This was the problem confronting the mid-west packer of the late 70's. Winter packing of hogs and some cattle and the curing, smoking and shipping of the products were well worked out, but supplying the East with fresh meat was solved only imperfectly by shipping live stock to local Eastern abattoirs for killing. The mortality was high, shrinkage heavy, stock often arrived feverish and in poor condition for slaughtering. Freight was paid on waste material. The steer of that day dressed-out a little over 50 per cent. carcass beef. The shipping problem was solved by the refrigerator car. Freight saving on moisture and waste came through the complete utilization of offal as wholesale by-product. Distribution was worked out by the establishment of branch refrigerator houses located on sidings in eastern markets. These houses sold the local butcher, who distributed the meat at retail. The western packer could pay more for stock than the eastern live cattle buyer and sell meat cheaper, as he recovered greater value from the animal. As the size of his operations increased, his per head expense was reduced. Incidentally, the railroads would not furnish refrigerator cars, so the packer built and operated them himself. He must have his car when he needed it if he were to perform his service. He required a good car, too, as he was shipping perishables which had to be delivered in perfect condition, or bang went his profits.*

The economics of the packing industry are sound; the distribution of the product is world wide; the service rendered is performed normally at a profit so small per animal that only multiplication on an exceptionally large scale permits it to be found in fair amounts on the black side of the ledger. For the last year or more, packers have taken their goods to market and paid for the privilege in substantial losses. Mr. Packer sells fiddle strings made from Montana sheep to the Pekin Chinaman and "thyroid" from the Iowa pig to the Swiss mountaineer suffering from goitre. He goes everywhere with his wares.

By-Products Utilization and Employment of the Chemist

The by-product packing house development was the first large example of practically complete utilization of raw material that this country had witnessed. The idea was novel, interesting and educational.

The first utilizations were along glue and fertilizer lines. Other developments followed rapidly, so that today about everything that comes from the animal is not only used but is made into a high-value product.

Farmers had been growing good crops long before the time of Liebig. Sugar, iron, copper and other products were made before the days of the chemist and the metallurgist. The "know-how" generally comes before the "know-why," but the greatest developments leading to uniformity of product, reduction of cost and increased yields, have come with the advent of scientific research and control. So it was in the packing industry, and it was not until the early 90's that those in

charge began to appreciate the possibilities of better product and increased economies through calling in the "know-why."

An Evolutionary Step Common to All Industries

At that time, many of the processes used in the preservation and preparation of meat products were semi-secret and the superintendents and foremen carrying on the work were inclined to build a Chinese wall around their activities and to keep the interrogation point away from their departments. The methods used in the manufacture of by-products as well as meat foods had been developed by practical men. These men were jealous of their prerogatives and felt that the scientific man was more or less of a menace or a nuisance. They were sure that their own work was one requiring personal knack and know-how—like good cooking—rather than science. The chemist had been called in occasionally as a referee or to analyze supplies or product, but the idea of having a two-storied scientific brain around the works had not been considered.

The same attitude was displayed towards other engineering problems and much rule-of-thumb construction was carried on. If it was thought wise to install a new department, the practical man did the designing in pencil on brown paper and looked after the construction. The trained engineer was occasionally consulted on some of the more technical problems. I well remember, in the early days of my connection with Armour & Co., of Mr. Philip Armour advising me that he had reached the conclusion that the days of the "boss carpenter" were over. We had had trouble with some of our building through improper design. He instructed me to study the question of organizing an architect's department and installing engineers and draftsmen, so that the future work might be planned. This was a favorable symptom.

Armour's First Chemist

The chemist first appeared upon the horizon of Armour & Co. in 1884. At this time, Prof. D'Lafontaine was called into consultation to determine the presence of cottonseed oil in lard. About 1887, W. B. Manwaring was engaged to develop the recovery of pharmaceutical products, particularly pepsin, but his duties were in the main confined to this department. It was not until 1893 that a chemist was regularly engaged for general packing-house work. At this time Dr. A. G. Manns took charge of the chemical laboratory.

The problems confronting the technical men coming into the packing industry at this period were by no means all chemical ones. Diplomacy played a greater part than actual chemical knowledge. As I already have stated, the different departments in the packing-house were in charge of practical men who did not feel that they needed technical advice or supervision, and were inclined to be very skeptical of anyone attempting to help them along these lines. The chemist, of course, had the backing of the official executives, and it was due to their broad foresight that he was enabled to gradually overcome the prejudices of the plant man. Up until 1893, all processes had been run absolutely rule-of-thumb.

* Address delivered March 23, 1921, before the City College Chemical Society of the College of the City of New York.

Growth of Respect for the Laboratory

After the chemical laboratory was established as such, the first problem tackled was the lard refinery, working to improve the quality of the various lines of fat produced. Shortly afterwards it developed that the products being manufactured in the pharmaceutical department were by no means standard and that uniform results were not being obtained by physicians in prescribing and using those compounds, due to the variation of the content of the active principle. The laboratory was asked to develop standards for all of the medicinal products and to undertake to check each day's product against these standards, so that an absolutely uniform medicine would be produced.

For many years beef extract had been one of the standard by-products of the packing industry. It was known that various batches apparently handled in the same manner differed widely as to color, odor and taste. Nothing was known, however, of the nutritive value; nothing was known as to the actual reasons for the above mentioned variations. This problem was put up to the laboratory and it was discovered that certain minor changes in the methods of making beef extract and certain separations of raw materials, would enable the factory to produce a uniform product of standard nutritive value.

The chemical laboratory by this time was thoroughly sold to the executives. Those departments which had been so materially aided by the laboratory in improving and standardizing their products, were also staunch supporters. Many of the other departments still considered their processes deep secrets known only to the superintendent of the department and his assistant; they resented bitterly any attempt upon the part of the laboratory to interfere with their methods, or to attempt to investigate their processes. They soon found, however, that the chemist was particularly valuable to them in giving assurance that their raw materials purchased were of standard purity.

It was found, for instance, that paprika was being adulterated; vinegar was being watered so that it was only about half strength; sugar was "sanded"; syrups were of high glucose-content. Occasionally a batch of product would "go wrong," and the chemist was often-times enabled to tell the department superintendent the "why" thereof. These department superintendents were in the main hard-headed, self-made workers, who were slow to take up new things, but able to grasp the value that the laboratory could be to them, and very quickly began to call upon the laboratory for more and more help.

Fertilizer Development

During the World's Fair in 1893, I had charge of the Armour exhibit which was located near that of the German Potash Syndicate. My attention was attracted to the possibilities of the fertilizer industry in this country, and how mere by-products of the packing house—tankage, blood and bones—could be expanded into a large independent industry. Shortly afterwards, I was given charge of developing this line and promptly called upon Dr. Manns for assistance.

At this time, I wanted to buy some sulphuric acid, nitrates and potash. On taking this up with Mr. Armour, I received a characteristic self-made-merchant letter authorizing me to dip into the chemical kettle, as he called it, but to be careful and not get burned; that a big business could not be started at the top and we must learn by experience how to handle chemi-

cals. We did dip into the chemical kettle—timidly to begin with—and have been dipping in ever since.

Phosphoric acid had been obtained almost solely from bones. Phosphate rock deposits of Carolina, Florida and Tennessee had been discovered and acid phosphate was being manufactured at southern and eastern plants. We were anxious to manufacture this article. It was desirable that this be started more quickly than machinery could be procured and installed. After consultation, it was decided that it was worth the attempt to try mixing phosphate rock and sulphuric acid in mortar boxes with hoes. The mixture was made, but the product was far from satisfactory, being wet and sticky and not at all suitable for mixing with other ingredients. There was no literature on the subject. The people who knew how to make acid phosphate kept it to themselves. One day a severe rain-storm came up while a vat of 60 degree sulphuric acid was out in the open. It rained hard for about two hours, and when the foreman and workmen returned to their mixing of acid phosphate, they discovered the vat of acid was apparently steaming. The laboratory was asked for advice.

Not knowing any way to strengthen-up the acid, they were directed to go ahead and mix this in the usual way and then go back to their regular acid supply. To the surprise of everyone, the acid phosphate mixed in this manner foamed up and produced an excellent article of a satisfactory mechanical condition. The foreman was at a loss to understand "why" such results were obtained, but upon referring it again to Dr. Manns, he immediately realized that a weaker hot acid was evidently necessary to produce the reaction desired. From that time on, there was no trouble in making satisfactory acid phosphate.

While it might possibly be considered an accident that this was discovered, the value of the laboratory is shown from the fact that the chemist immediately realized why success had been obtained. If we go back in history, we find that the untrained mind does not readily absorb the value of such accidents. You have all ready Lamb's "Dissertation on the Origin of Roast Pig." You will remember that at first it was considered necessary to burn a house in order to obtain-cooked pork to eat. The trained mind would undoubtedly analyze the situation and build a fire in the open to roast a slaughtered animal. In like analogy, the workmen would probably have waited for another rain to dilute their sulphuric acid, or would have overlooked the factor of water entirely. The chemist instantly realized that the mere addition of water to the acid would bring about the required results.

Many problems came up from time to time in the development of the fertilizer industry. Nitrogen, being the highest priced of the three elements of plant food, drew the chemist's attention first. Conservation of all nitrogen-bearing wastes of the packing house was first studied and accomplished. Nitrogen-bearing waste materials of other industries were investigated and in many cases where the nitrogen was largely inert, processes were developed to treat such materials so as to render their nitrogen-content available for assimilation by plants. The latest research is along lines of fixing atmospheric nitrogen by means of the electric furnace so as to produce ammonia and nitrate salts.

Fertilizer chemists have for years been trying to make the phosphoric acid in phosphate rock available for plant food without the use of sulphuric acid. A great many patents have been issued covering all sorts

of processes, mainly, however, specifying heating to a more or less degree with certain chemicals. Although certain experimental successes have at times seemed achieved, yet no operation on a commercial scale ever has been attained.

The scarcity of potash during the past six or seven years stimulated the chemist to search for chemical means of rendering soluble the vast deposits of this country existing in the insoluble silicates such as feldspar, leucite, green sand, marls, etc. Also much work was done on the separation of the various soluble salts in the vast deposits of brines in the West. Alunite, the double sulphate of aluminum and potassium, was researched until a satisfactory process was developed, a plant built, and a steady production of very high grade sulphate of potash maintained up to now.

The fertilizer end of the packing industry has, perhaps, made greater use of the chemist than have other lines. This is especially true in our company where the chemically trained man is used not only in the control and research laboratories, but in the plant and in the manufacturing, purchase, sales and executive divisions. Chemical control of manufacturing is maintained in some twenty-odd plants located in the different consuming sections. Guess is eliminated—we find it pays.

Present Packing House Problems

The problems of the packing house chemist are largely refinements of the primitive problems of thirty years ago. He is expected to watch all processes and keep them under chemical control so that only prime products are turned out. The sterilization process in the canning room, for instance, must be so standardized that there can be not only no chance for any putrefactive bacteria or fermenting organisms left alive, but also the material must not be overcooked so as to spoil its appearance and taste.

The development of the margarin industry has caused a great demand for chemical research and control. The various vegetable and animal oils must first be refined to the point where in taste and color they are palatable. They must then be blended so that when churned with the milk, the resultant product so closely resembles butter that the average consumer cannot tell the difference.

The first recovery of pharmaceutical products by the packing house is pepsin. Now practically every gland is collected, and its active principle segregated and purified. No less than 35 different pharmaceutical and medicinal products are now manufactured. Extracts of all the ductless glands, all the digestive ferments and enzymes, haemoglobin, blood albumen, etc., are prepared. Certain organs whose active principle is yet unsegregated are carefully desiccated and used as medicines in this form.

I could carry on these illustrations for every operation and department of the industry, showing the influence and necessity for technical control of the industry; could go into the detail of the purchase of all raw materials—how the chemist draws the specifications for these materials, from the brass journal bearings on the wheels of a refrigerator car to the strength of the attar of roses to be used in the highest grade soaps. However, there is another most important function of the chemical laboratory.

Administrative Men from the Laboratory

One of the greatest benefits the packing house has received from the chemical laboratory is the men it has

furnished. More and more it is found necessary to replace the rule-of-thumb operator with one technically trained. The laboratory is found to be an excellent place to analyze men as well as materials. There are plenty of opportunities for the routine analyst to use his ingenuity. Many operating troubles are given the laboratory to solve and here is the golden opportunity for the man detailed. He is privileged to view the conditions from a new angle, and is often able to see a simple fault more quickly than those who have been long in close contact with the process. Often it is necessary to demonstrate personally the remedy, and the value of the trained technical man is proven. He is given further chances and is soon transferred to a position directly operative in its character. Do not think every analyst gets such promotions. He merely gets opportunities that lead to such. It depends on his own character fully as much as on his ability whether or not he makes the most of them.

Unfortunately in the past some technical educators have led their disciples to believe that they must avoid the laboratory; have insisted that only factory operating positions were worthy of consideration; have warned that to accept an analyst's position was to abandon all hope of ultimate success. In our experience the reverse is more nearly correct.

For the Chemist Who Would Be a Plant Executive

To be a successful factory executive, a man must know and understand every operation under his control. He must appreciate the value of the analyst, realize his limitations and profit by his reports. He should be able to interpret a chemical analysis as readily as an architect can "read" a blueprint. Only by actual experience with test tubes can such ability be acquired.

So we believe the young chemist or chemical engineer just graduating can spend a year or even two years to no better advantage than in the control laboratory of some large company. There are those men, of course, whose whole thought and ability tend to research, and they must choose their work accordingly; but we speak of the majority. Inasmuch as present business tendency is to turn its operating matters over to specially trained technical men, the graduate chemist must fit himself for such work.

The laboratory offers perhaps the best opportunity to learn the intricate details of all departments, but also affords him a broad view of the industry as a whole. It then rests with the individual man as to whether he will rise to his opportunity and handle the situation as it confronts him.

Since 1894 the chemist has made substantial progress in blazing his trail in the packing industry. Much work is ahead of him. The industry, with its many ramifications, has great need for further chemical development in all of its lines of activity. The call for technically educated men, both in the manufacturing and executive departments, is constantly increasing as their value is better understood and appreciated.

Modern business is becoming more and more an engineering proposition. The technical student of today will have many opportunities for work, for service, and for success. He, on his part, must round out his personality; must endeavor to become increasing hard-headed without becoming boneheaded; he must be tolerant; he must prepare himself to be a good mixer and make himself understood and appreciated by other than scientific men; he must not under-rate these men because they have not been technically educated, as they

may possess certain abilities he is shy of; he must study co-operation and be prepared to do team work with his colleagues.

He must appreciate the fact that the ability to make money in a large way is not possessed by all people, but that industry, thrift, character, courage, decision and good judgment will permit him to secure just compensation for his services and a competence for the days to come; he must understand that money received is not the only equivalent for work; that satisfaction from successful service in developing new and better

ways of accomplishing important results is after all the highest type of compensation; he must realize that by the elimination of jealousy and by using his monkey wrench, if he possesses one, as a constructive tool, he will so ally his services and his personality with his colleagues that success naturally will come to him.

Such men as Manns, Richardson, Lowenstein, Tolman, Vollertsen, Rudnick, Powell, Hagedorn, Lodge, Fenger and others have done much for the packing and related industries. For the chemist in these industries, the end of the trail is not in sight.

Industrial Co-operation with Department of Commerce

In pursuance of a plan to correlate the services of advisory organizations with the work of the Department of Commerce, Secretary Hoover has settled on five sub-divisions of the work, viz., textiles, coal and oil, chemicals, leather products and foods. Advisory organizations representing these fields already have been completed for immediate functioning with the department. Additional divisions will be announced.

The work of the committees undoubtedly will be mostly experimental for the first six months until a routine of necessary duties can be established for each of the advisory organizations. Each group will comprise two experts in each line to direct trade development activities.

Similar groupings will be installed in the Bureau of Standards and the Census Bureau, in order to correlate the work of the Commerce Bureau by providing the necessary statistics for the basic commodities and aiding in the standardization of export products.

Phosphate Production and Export

Florida, which produced 82 per cent. of the phosphate rock of the country in 1920 and which since the beginning of production in 1888 has produced 40,239,898 tons valued at \$156,318,078, yields pre-eminence in extent of deposits to the recently surveyed field, 500 x 300 miles in area in the eastern counties of Idaho and western counties of Wyoming, extending northerly into Montana and southerly into Utah. The commercial possibilities of this field, estimated by the Geological Survey to contain fully 100 billions tons, was first shown about 15 years ago.

The Anaconda Copper Co.'s holding are estimated at 100 millions of tons of high-grade rock. Equipment for the first 750-ton crushing and drying unit of what is planned to be a 3,000-ton daily mill plant is now being installed. Preparations are being made at Portland and Seattle to handle Oriental export shipments.

The Phosphate Export Association, comprising four member concerns in New York City, viz., International Agricultural Corp., Coronet Phosphate Co.; The Phosphate Mining Co. and Southern Phosphate Corp., have combined for the purpose of export trade with the Florida Hard Rock Phosphate Export Association, comprising five member concerns in Florida and Georgia, viz., J. Battenbach & Co. of Dunnellon, Fla., C. J. Camp of Ocala, Fla., Cummer Lumber Company of Jacksonville, Fla., Dunnellon Phosphate Co. and Mutual Mining Co., Savannah, Ga. Papers have been filed with the Federal Trade Commission under the Export Tract act (Webb-Pomerene law). The main office of the combination will be located in New York City, with branches in Savannah, Georgia, and London, England.

Joint Trade-Marks in Export Trade

In accordance with a new feature in the development of foreign trade whereby joint, uniform brands and trade-marks are adopted by associations organized under the Webb-Pomerene act for the purpose of export trade, the U. S. Alkali Export Association of New York has abandoned the use of individual marks, and reports the adoption of a new association trade-mark which will be advertised through their agencies in South America, Cuba and Mexico.

The trade-mark "Apex" is found on some 200 varieties of paper and board shipped by the American Paper Exports, Inc., of New York to Europe, Asia, Africa and South America. The American Milk Products Corporation of New York, which has a branch in China and maintains agencies in Europe, has adopted a new label to be used on shipments of evaporated milk. Meat is shipped by the American Provisions Export Company and the U. S. Provision Export Corporation, both of Chicago, under the marks "Apec," "Uspec" and "Vigo." Trade-marks and stenciled designs are used by the Cement Export Company, Inc. of New York; the American Tanning Materials Company of New York; and other associations operating in export trade under the Webb-Pomerene act.

In advertising American goods abroad, concentration on one or a few brands or marks, which convey a guarantee of quality, has proved to be much better business than the use by one association of a bewildering number of individual marks which may compete with each other and confuse the foreign buyer. Aside from advertising value, this feature represents an important step toward co-operation in export trade.

Disposition of Municipal Cement Plant

The cement plant at Monolith, Cal., which belongs to the city of Los Angeles, is being operated by the United States Potash Co. as lessee. It was built by that city in 1908 to supply the cement required in constructing the concrete aqueduct by which water is conducted from Owens River to a reservoir near Los Angeles—a distance of 220 miles. The plant was run by the city from March, 1909, till March, 1913, this having been the period during which the aqueduct was under construction. In that time 899,884 bbls. of cement were made. The plant was leased to the county of Los Angeles in 1915, with an option to purchase at \$550,000, but this arrangement was cancelled by a court decision. The city then operated it during a part of 1917, but closed it down in January, 1918. This was followed by an offer to sell the property, including mill, lime and clay deposits, and townsite at \$450,000, the city's original investment having amounted to \$896,000. The United States Potash Co. took possession as lessee early in 1920.

Some Problems of the Dye Industry

By Clarence K. Simon,

President, Dye Products and Chemical Co., Inc.

THE challenge of the environment which urged men to undertake the development of our domestic dye industry, a line of endeavor highly technical in its nature, extremely complex in its makeup, fraught with numerous pitfalls, full of obstacles to be overcome, and one largely speculative as to its continued existence, finds its analogue in that spirit of conquest which ever has urged man to bend the resources of nature to his purpose.

The building which had to start at the very foundation of things, and which, under normal conditions, would have been accomplished by an evolutionary process was, under the circumstances, necessarily carried on under the enforced pressure of a stoppage of our source of supply, with all its attendant hardships. The results of that endeavor have been successful to a degree far beyond the expectations of a brief period ago.

There were many problems which arose and which are still presenting themselves to our dye-makers, and it is here intended to discuss some of those problems which are among the most prominent.

Selection of Lines of Manufacture

In the wild scramble to produce, following the imposition of the British blockade on German dyestuffs coming into this country, men who realized the seriousness of the situation of a country without dyestuffs began asking themselves the question: Where shall we begin? What shall we manufacture? It was a problem to know what to tackle first. To start from the basic coal tar, obtain from it the various crudes, convert these into the numerous intermediate products, and finally to transform these into a myriad of colors for the needs of a great number of industries, and to do all this quickly, were little less than a herculean task.

Obviously the work had to be done in stages by numerous manufacturers, so that each might contribute his share simultaneously to the development of the industry. If there had been some central agency at work to direct lines of endeavor of the various manufacturing concerns who responded to the task, much time and duplication of work would have been avoided. Unfortunately, there was no such agency, and it remained for the economic law of supply and demand to manifest themselves before real progress was made.

This problem of deciding what to manufacture and what to purchase is still present with the dye-makers, and although some of the larger manufacturers have solved it by making all the crudes and intermediates which they use, a large number of the moderate sized companies out of a total of 214 manufacturers of dyes and intermediates are still confronted with this question. By far, the great majority of dye and intermediate manufacturers do not make their own crudes, since these, by the very nature of things, are by-products of the manufacture of coke used mainly in the steel industry, or are obtained as by-products of the manufacture of illuminating gas. In most cases the steel and gas companies were well qualified to produce these materials, both because they had the necessary resources and also because by so doing they would be able to manufacture the main products more cheaply.

In the matter of intermediates, the question was and still is, whether the purchase of these products from other manufacturers would enable the user to make up

his dyestuffs, the cost of which would then contain the profit of the intermediate manufacturer and to find the market still able to bear this extra tariff, or to be able to compete with the dye manufacturer who makes his own intermediates and who puts his profit on the final product of the series of manufacturing operations necessary to make the finished dyestuffs.

Of course, another factor which enters into the question, is the conditions under which these intermediates are manufactured. Some intermediates, such as aniline oil, beta naphthol and paranitraniline, for instance, which are used in other industries besides the dye industry, are consumed in large quantities, so that their production is on a very large scale, making it possible for the intermediate manufacturers to offer them at prices cheaper than they could be made by the color-maker. Then again, the specializing of some concerns on certain products enables them so to develop their technique of manufacture, that they are placed on a more favorable basis than concerns that do not so concentrate, and thus are able to manufacture more cheaply than the latter.

Inasmuch as the industry is still so young, the status of those manufacturers who purchase intermediates is continually changing, insofar as it becomes necessary, as changes in market conditions occur, either to take up the manufacture of these intermediates themselves or to sell their dyestuffs at a smaller margin of profit. On the other hand, there always will remain a large number of intermediates which the dye manufacturer can purchase advantageously, all things considered.

Plant and Machinery

The technical side of the dye and intermediate industry is the all-important one. It is the development of this phase which our German competitors have carried on to so high a degree of perfection in the forty odd years that the dye industry has been in existence.

We are confronted here with problems which have no counterpart in any other industry. It is to the great credit of our manufacturers that they have accomplished in a period of six or seven years what it took the Germans almost a half a century to do.

One of the most important technical problems is the question of plant layout and design, and the selection and design of the machinery and equipment. The engineering side of the subject must be studied carefully for each particular operation out of the many hundred such to be performed. This study must embrace the smallest details of the requirements in order to assure smoothness and efficiency in operation.

Even though the chemical efficiency of the process be high, if the engineering be faulty, the result invariably will be failure. Probably in no other manufacturing operations is this so vital as it is in the manufacture of dyes and intermediates, due to the wide range of conditions met with, the great variety of materials to be handled, the great differences in the properties of these materials, and the numerous phases of temperature, pressure, speed of reaction, etc., to be maintained.

Such operations as the transportation of materials, methods of agitation, filtration, heating, cooling, distillation and sublimation, evaporation, drying, grinding, centrifuging, etc., when considered in connection with the hundreds of products to be dealt with, test the skill of the chemical engineer engaged in the dye industry.

to the utmost and it is often only by much resourcefulness that he is able to effect a satisfactory result.

A very troublesome question to the dye-maker is that of the corrosive action of the materials handled, on the machinery and systems through which the material travels in its route through the factory. Hundreds of different kinds of products with different degrees of corrosion are used or manufactured. It becomes essential for the dye-maker to reduce this corrosion and wear-and-tear factor to a minimum, for it is one which sends up costs quickly.

In the early days of the industry, the machinery and equipment manufacturers did not have the necessary apparatus to offer the dye-maker, but with the development of the latter industry, the former also developed proportionately so that many of the problems in this direction have been solved successfully. As an example of the heavy manufacturing burden under which the industry struggled, there may be mentioned the case of a manufacturer making diphenylamine, an intermediate product.

In one stage of the process, an enamel-lined digester was required, as this was the only available machinery that was known to withstand the action of the materials used. These digesters would not last more than a week, as they would either crack or the enamel would chip off, and so make them unfit for use. Until a satisfactory and available substitute was found, the cost of manufacturing this particular article was greatly increased by this enormous replacement expense. The situation was quite similar in the case of pumps, piping and fittings. While the many special alloys and other materials since put on the market have gone a long way to alleviate the trials of the dye manufacturer with respect to corrosion, this question is an ever present source of trouble.

Changes in Plant and Processes

After the dye-maker has perfected the manufacturing technique of a certain process, after his machinery and equipment for this process have been evolved to a high state of efficiency, both in regard to speed of production and low maintenance and repair costs, his research department suddenly may advise him that, after much diligent work, they have perfected a better and cheaper process for making this same material. He then seriously must consider discarding his present process, which in many cases also means that he must change around or even replace his equipment for this process, in order to avail himself of this new advantage. If he fails to do so, sooner or later his competitors probably will work out some improvements for themselves, and so force him to make the desired changes in the end, notwithstanding. These questions continually are coming up in the dye industry, and while the machinery and equipment in most cases are not discarded entirely, yet often the changes or additions are quite costly and the pros and cons must be well weighed before making a decision.

Yields

In most lines of industry a manufacturer can figure definitely his costs of raw material and be reasonably sure that the results of his processes will give him a certain amount of finished product from a specified amount of raw product. In other words, he is reasonably certain of the manufacturing yields coming out consistently and also that his competitor is getting about the same as he is. Not so in the dye industry.

The reactions are so delicate, the factors to be controlled so numerous, the conditions to be observed so

exacting, that do what he will, the dye-maker is confronted now and then with the problems of low yields, off-shade material or spoiled batches. Of course, there is an allowable limit to the frequency of these mishaps or to the lowness of the yields, but this "sword of Damocles" always is hanging over his head. By the building up of an efficient personnel, by instituting various safeguards and controls such as automatic temperature and pressure regulation, by laboratory control of the various stages of manufacture, and by the careful design and selection of the equipment used, this troublesome factor may in time be reduced to a minimum.

Then again, one manufacturer may be operating under a process which gives him a yield of say 60 per cent. of the theoretical, while another manufacturer may have so improved his process or his technique of manufacture that he gets 80 per cent. of the theoretical for the same product. In one particular case known to the writer, the yield was raised 30 per cent. by simply increasing the speed of the agitator in a kettle by twenty revolutions per minute. These are facts, which are not found in text books, but which time and experience alone can give to the dye industry.

By-Products

If the manufacturer of dyes and intermediates always produces the substance he desires and just that and nothing more, his troubles would be lessened greatly. Unfortunately, due to the formation of isomeric substances, he very often produces other compounds, as by-products of his main reaction. These not only use up his raw material, but they must be separated from the main product which he desires to produce in the first place, these separations often being quite involved and costly. In many cases these by-products are a drug on the market, so that much effort must be put forth continually either to develop new uses for them or to make them so cheap that they will be attractive to old markets. The economies of the business demand that they be utilized, rather than run to waste.

Take the case of orthonitrotoluol and paranitrotoluol. These two products are formed simultaneously when toluol is mono-nitrated, in the proportions of about one third of the para compound to about two-thirds of the ortho. The para compound is much in demand and brings about four times as much in sales value as does the ortho compound, yet the cost of manufacturing these materials is about the same, it being merely a question of separating the one from the other by physical means. The question of disposing of the ortho compound must always be taken into consideration, so that this will either limit the production of para, or, if the ortho compound were run to waste, this might send up the price of para to a point where it would be unsalable.

Then again, there are many by-products for which the manufacturers have found as yet no particular use. In many cases concerns are storing up huge quantities of these materials in the hope that some day, due to changes in conditions or as a result of successful research experiments, these products may find a market.

Costs

From all that has been said it will be understood readily, that the question of cost-finding in the dye industry is the most difficult one, yet a most vital and necessary problem to solve, for the success of any enterprise depends upon accurate knowledge of the costs entering therein. Owing, however, to such ques-

tions as changes in processes, discarding of machinery, disposal of by-products, plant development and research, the question is indeed a vexing one.

According to a study of the costs of production in the dye industry made by the U. S. Tariff Commission, the variation in these costs among the different manufacturers is startling. Variations of from 50-200 per cent. of the average cost figure on any particular product are not uncommon; the individual items entering into the total cost figure also are quite different among the several manufacturers. There seems to be no relationship between costs and the quantity of material produced. Even among companies producing the same material with about the same output, the costs vary greatly. No doubt many of these variations are due to the unstandardized cost systems in use among the companies.

The American Dyes Institute last year performed the needed service of compiling uniform cost accounting methods and when these are put into use in the industry, it should make for more stable conditions, as many manufacturers who in the past cut prices often did so without a true knowledge of their costs, and perhaps, in some instances, caused commotion in the market for the time being until prices sought their proper level.

Labor

There is yet one more question which deserves consideration, and that is the question of labor. We are told that in the German dye works, sometimes two or three generations of families are represented in the working forces and that these people are, so to speak, born and brought up in the dye industry. They thus acquire a certain attitude of mind, they develop a certain temperament and attain a degree of workmanship that particularly fits them for this line of employment.

How different are the conditions existing here! When the industry was started, there were no trained workers to choose from, and practically all of the 25,000 workers now engaged in the industry had to be selected from perhaps seven or eight times that number, by the tedious process of trial experiment. All this had to be done during a period when wages were extremely high and when additional inducements had to be made to workers in order to recruit them from other lines of work. Now, however, the labor problem has simplified itself somewhat, owing to the decrease in the demand, but the same careful and painstaking method of selecting men for this work must be maintained.

While the operator, or process man, in the dye industry must have the ordinary amount of intelligence and other necessary qualifications, he should in addition possess other characteristics which make him particularly fitted, and these are principally an exactness for details, a high regard for accuracy and a well developed power of observation. With these characteristics a man working six months in a dye plant should develop into a valuable asset to the industry. It is the goal of having a force of workers possessing predominantly the above qualities that most concerns are striving to attain. Perhaps some time in the near future employment psychologists will make a special study of conditions in this industry and so aid in the process of perfecting its personnel.

Policy and Protection

If a dye industry is wanted in this country, then, considering the complexity and highly technical nature of the business, it is incumbent upon our law-makers

to give it adequate protection so that it may develop. That it is to the best interests of the country to have a dye industry within its confines is a question that has been too often discussed in the past to need further elaboration here. Suffice it to say that had this protection been given a year or two ago the dye industry would have been much more highly developed than it is today. The policies of most concerns engaged in the industry have been greatly influenced by this omission and they have been holding back in research, development and plant extensions because of it. The time has arrived when action by Congress in expression of the people's will and not in subversion thereof in favor of any particular group, is vital; for to permit the German trust to make itself felt here will mean a wrecking of all that has been done in the past seven years in America to make our country self-contained in the chemical essentials of war and peace.

Cooperative Analytical Program of the American Oil Chemists' Society

Frank N. Smalley, chief chemist, Southern Cotton Oil Co., Savannah, Ga., desires on behalf of the American Oil Chemists' Society, the collaboration of laboratory directors and analytical chemists of industries, particularly in the North and West, devoted to the utilizations of carbohydrates, glycerides and proteins embracing respectively such products as (1) flour, sugar, starch, etc., (2) fats and oils, and (3) oil meals, brewer's grains, beet pulp, gluten feeds, fertilizers, etc., in the cooperative analytical program of the American Oil Chemists' Society.

The main object of this collaboration is to provide a reliable means whereby chemists may discover tendencies on the part of their laboratory organizations to deteriorate in the accuracy of their analytical work, and to locate and eradicate the causes.

In some industries, notably the metallurgical, this end is attained by the use of standard samples, obtained as a rule from the Bureau of Standards. In the organic chemical industries mentioned, analytical work, upon whose results are based the commercial transactions of the business and because of the character of the products, cannot be standardized in this manner.

The importance of this subject and the enterprise of the American Oil Chemists' Society in inculcating accuracy and reliability in the work of its members warrant the prompt and general request of analytical chemists in these branches of the chemical industry for the detailed printed information which Mr. Smalley has available.

The H. W. Johns-Manville Co. has resumed work on its new plant at Waukegan, Ill., a project involving an estimated investment of \$6,000,000.

The Canadian Johns-Manville Co., Ltd., with sales office at Montreal and Toronto, and which for several years has been operating asbestos properties at Asbestos, Que., has awarded contracts for the erection of a plant in that town, where it will manufacture all classes of asbestos products formerly imported from the United States.

Judge Mayer, of the Federal District Court of New York, has denied the contention of the Alien Property Custodian as to the German ownership of 1990 shares of stock worth \$590,000 in the Farbwerke-Hoechst Co., 122 Hudson St., New York, and confirmed their ownership by ex-Congressman and former New York City Controller, Herman A. Metz.

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TO the technical man out of a job; to the working-man demanding a war-wage rate and suffering unemployment in lieu thereof; to the producer of raw materials whose unsold surplus denies him the power to buy; to the manufacturer reducing overhead to the skeleton of a production organization; to the distributor who weights unduly the margin of his toll; to the stockholder upon whom now is beginning to fall the embarrassment or reduced and passed dividends; to the bondholder whose security quotations reflect the prostration of industry; to the banker who perforce becomes a trader when the market wipes out the equity of his loan; to transportation agencies abuse of which is the prime demoralizing influence in American life and industry; to the politician who perverts the power of public trust to projects that too often only can bedevil the general good; and to that embracing class, the consumer, who bears the burden of it all, comes the question of how long will it last—this unbalanced state of industry that fails efficiently to function in a world sore-pressed by needs.

To the chagrin of economic experts who a short time ago taught that the world had attained a new level of prices which must become permanent if a progressive standard of living is to be enjoyed, comes the reverberation of this unconfirmed doctrine from groups which demand it in the face of economic law which, working for the general level of the exchange values of goods throughout the world, declares that for every debauch there must be recovery. If the individual, institution, industry or nation is to resume its customary service in the work of the world.

ORGANIZED resistance to the operation of economic law, whether in the form of fulminations of demagogues or the machinations of profiteers, or of the programs of politicians, in the hope that there can be made permanent to a class or a nation the temporary advantages of world disorganization, only delays this recovery.

The present depression differs from its predecessors in the fundamental soundness of our economic structure and in the perverse vigor of the human will in its desire to penalize the common weal to class advantage.

The co-operative processes of an industrial society, interdependent as at no time in history, must not be denied that free play that works for the good of all.

RESTORATION of business activity will be measured by the degree to which all the elements that enter into production costs contribute their respective portions to the readjustment of unbalanced conditions, which process involves a reversal of the causes which produced them.

Plainly the present responsibility is that of labor to remove the incubus of its demands that consumption vitalized by the will to pay may stimulate production.

Labor as a whole gets the produce of industry. If one class gets more than its share, it does so at the expense of other classes of labor. Organized labor, by the cowardice of politicians, has become avaricious to the degree that national welfare is subordinated to the interests of a favored class.

We have in the refusal of labor to bear its share of the burden of readjustment that goods may be sold at a price that will permit employment, the heart of the distress that afflicts America.

DOMESTIC business conditions are inseparable from the maintenance of our export trade which, though only a small part in volume and value of production for domestic needs, makes possible that capacity operation which insures the most favorable distribution.

This phase of our readjustment problem is of the utmost influence in the utilization of our increased production capacity. To the present great under-production has come a recession in foreign trade to pre-war figures, upon the one hand reflecting the unsettled economic conditions abroad and upon the other indicating the dependence of our own prosperity upon the capacity of foreign markets to buy and pay.

To protect our incomparable home market without such inhibition of importation of foreign-made goods as will deny to other lands the power to buy our surplus, is the problem in economic experimentation at Washington.

American industry will struggle feebly to its feet so long as the rest of the world remains in disorder and until we recognize our responsibilities in its economic leadership.

IN derogation of the campaign slogan of "less government in business" and as a precedent to reopen the Muscle Shoals proposal for the government operation of a fundamental industry for the assumed benefit of a class, is the Senate bill endowing the Secretary of Agriculture with the control of the packing industry which, as indicated in the "Census of the Chemical and Allied Industries," is our largest single industry.

On an unsurpassed volume of business, with the

smallest known margin of profits possible only by the strictest economies, it is impossible to see how restriction of enterprise in this field will net the farmer more for his cattle and reduce the cost of their products to the consumer.

The transfer of the control of an industry extending to the four corners of the earth from private initiative to a bureaucrat at Washington, is too great a concession to the clamor of class at a time when much of our present ills results from the discretionary power of individuals clothed with brief authority.

Insidious is the penetration of a vicious philosophy that would pervert a government of laws to one of men.

THE human body as a model of specialization of function and coordination of parts is the most efficient apparatus for a definite purpose known. From a single-celled organism to the subject of Shakespeare's apostrophe—"What a piece of work is man!"—it not only epitomizes the evolution of the race but is the analogue of its material achievements.

Unnumbered eons elapsed before the principles of organic development became the basis of modern civilization and man himself scrutinized its functional deficiencies.

Organic progress in biology or material progress in economics means growth in efficiency, in the elimination of waste whether in method or material. In the former the process is unconscious; in the latter the same steps are the result of conscious study.

AT a time when man's perversity drives the world to privation, technical men are impelled to study industrial and social processes that adaptation of means to end may be with greater service in cheaper and more abundant goods.

The report of the American Engineering Council placing the responsibility for 50 per cent. of the preventable waste of industry to management and 25 per cent. to labor, is one of the most important documents in our industrial history and is valuable especially as an index of social introspection—of that organized self-scrutiny that paves the way to improvement.

Waste always has existed. Its progressive elimination means progress. In organized industry we can distinguish between the waste eliminated by competition and expressed in lower prices or improved service or both, and the waste incidental to the competitive system under which we live and most marked in the distributive processes. Waste of the latter class is far less than would be inherent in any system that vainly would seek to nullify the operation of natural law in the ambitions of men.

THE United States Government is the greatest spending agency in the world, without any of the inhibitions that condition the success of private enterprise. With resources limited only by the patriotism

of the people, it has been the historic example of the slackness of democracy instead of standing as a precedent and pattern for industry which it primarily serves.

The per capita burden of \$500 for its support, 93 per cent. of which is applied to the purposes of war, is a waste of the first magnitude that calls for reduction. Initial efforts of Herbert Hoover to inculcate administrative efficiency are meeting in certain quarters with bureaucratic antagonism, abetted by legislative favor, that deserves prompt and effective rebuke.

WITHOUT any desire to seek to trespass upon existing agencies of service to chemists, even in the state wherein its excuse for existence has been demonstrated by its own virility, in fact inviting the organized effort of others if it be felt that they can do a needed work better, Dr. Crane, secretary of the New Jersey Chemical Society, outlines the plans and purposes of that organization to establish standards for the profession of chemistry.

New Jersey is the foremost chemical manufacturing state with an industrial environment exceptionally favorable to working out the problems of an economic organization of chemists with well-defined purposes.

The American Institute of Chemistry, into whose formation it is hoped this movement will grow, with its precedent in the Institute of Chemistry of Great Britain, will not be a competitor for the loyalty to any existing organization, but seeks to supplement a valued service by the performance of functions hitherto neglected and ignored; and hence will be a cooperative organization born of the conditions of existing service and administration and of the needs of the time.

Its sponsors reflect the opinion of a great body of American chemists that there should be competition in service to the rapidly increasing numbers working in the science, art and business of chemistry, particularly when such performance of service involves no duplication of effort, but seeks specific duties best performed by an independent organization meriting the good-will of all.

The satisfactory performance of economic functions touching the individual chemist in his training and his work, as distinguished from his scientific and educational interests, does not lend itself to administrative methods of omnibus operation that increasingly call for the creation of committees with the development of a chronic distress happily called *committecitis*, but requires that specialization that experience teaches is the most effective for results.

Accordingly, Dr. Crane, in his direction of this movement, solicits the constructive suggestion and cordial cooperation of chemists everywhere who see not only the need of an economic organization of chemically-trained men, one of whose functions will be the establishment of professional standards in the practice of chemistry, but the compelling consistency of its distinct identity worthy of the encouragement and cooperation of existing organizations.

Personnel and Spirit of the Solvay Process Co.

THE general reorganization of the administrative personnel of the Solvay Process Co., Syracuse, N. Y., and the concentration of the control of the widely distributed and varied manufacturing activities of the company at Syracuse, are notable not only because of the pre-eminence of the company in heavy chemical manufacture and its affiliation with the Allied Chemical & Dye Corporation, but as a commentary upon the necessity for efficiency expressed in low production costs which confronts manufacturing enterprise everywhere.

From initial employment as a messenger in the main office at Syracuse, Edwin D. Winkworth rose to the vice-presidency of the Semet-Solvay Co., to be advanced, by the resignation of H. H. S. Handy, to the presidency; Mr. Handy, while remaining as a director, will be occupied with the more embracing responsibilities of vice-president and director of the Allied Chemical & Dye Corp. Robert W. Swift, formerly treasurer of the Solvay Process Co. and vice-president of the Solvay Collieries Co., now directs as senior vice-president of Wing & Evans, Inc., 22 William street, New York, the distribution of Solvay products.

Andrew H. Green, Jr., vice-president and manager of the Detroit plant, has been transferred to Syracuse where he will serve as vice-president in charge of operation and engineering. E. H. Bingham, formerly plant manager at Detroit, and A. R. McFarland, formerly chief engineer at Syracuse, have been made respectively manager of operation and engineering, and technical assistant to Mr. Green.

L. S. Tracy, formerly assistant to the general manager, is now Mr. Bingham's right hand man, to whom all plant managers will report. C. G. Mallory, formerly industrial relations manager, is now chief engineer, and is succeeded by W. C. Shalldross, formerly plant manager at Detroit. C. Sundstrom is acting chief chemist. Byron L. Thompson, formerly manager of the Salduro, Utah, and Boro-Solvay, Cal., potash recovery plants, has been placed in charge of operations at Hutchinson, Kan., and J. P. Clune, formerly in charge at that place, is now manager at Detroit. G. S. Rutherford is manager of the Syracuse plant.

C. K. Mallory, chief engineer, in pursuance of the work of reorganization of departments under the new plan of centralization, has made the following appointments: C. L. Griffin, assistant engineer, in charge of design for all plants; C. S. Glinn, assistant engineer, in charge of maintenance and construction for all plants; E. R. Blinn, engineer, Syracuse plant; F. F. Bontecou, engineer, Detroit plant; and A. L. Campbell, engineer, Hutchinson plant.

Mr. Green accompanied the announcement of the personnel of his staff with a message which, while directed to them and to the employees of the entire organization, is of such significance to chemical manufacture in general as to warrant its extension to the entire industry. Mr. Green said:

"The duties of these men will not be confined to any one plant, but will cover the work of all the plants. The larger problems of manufacture, repairs, construction, designing and chemistry, quarry operations and labor and safety will be supervised and worked out at the Syracuse office.

"We confidently expected and now absolutely know that this concentration at Syracuse will reduce the

consumption of raw material in manufacture at all the plants, reduce repairs, lower the cost of construction of new buildings, and in short reduce the costs of all the operations of the company entrusted to this department. The reason, therefore, for the creation of this staff is to better attain economy, which is necessary in our business at any time, and is imperatively necessary now.

"By a quick comparison of the results in every works of all activities coming within the jurisdiction of our department under control of the staff, we will be able to know more promptly what plant attains the best results and what men and machinery are responsible for such results. Every effort will be made by the staff to aid the works not attaining such good results to obtain better results.

"However, the staff relies mainly on the spirit of co-operation, team-work and pull-together—to get the best results. The co-operation, team-work and pull-together spirit has not been poor between the Syracuse office and our works at Detroit, Michigan; Hutchinson, Kansas; Salduro, Utah; or Boro-Solvay, California. In fact, it's been good—very good.

"But in these times neither good nor very good is enough. IT MUST BE THE BEST, and we will have it no less.

"In no less measure we expect the same spirit of co-operation, team-work and pull-together between the various staff officials and the managers of the different works of the company wherever they may be in the United States.

"In each plant we expect the spirit of co-operation, team-work and pull-together between the managers of the different departments.

"We expect the same spirit of co-operation, team-work and pull-together between the foremen in each plant in their business with other foremen.

"And last and not least—we expect the same spirit of co-operation, team-work and pull-together between the hourly men and other hourly men in the same gang or in other gangs.

"Therefore—if you are not on the very best working terms with anyone with whom you do business in the works, get together with that man, talk it out with him, and only with him. If you can settle your misunderstanding with him and shake hands like a man, frankly and honestly do so. But not otherwise. If you can't get together on the first talk, have a second one and have as many more as may be necessary for you and that man to get where you can say to him, 'I will co-operate with you, I will play team-work with you, I will pull-together with you.' And then make this resolution, 'I will co-operate, play team-work and pull-together with every man inside the department in which I work and outside my own department with every man I come in contact with in the course of my daily work.'

"The times demand it and we ask the hearty co-operation of every one in making your work and our work the best, and we will not be satisfied with ourselves or you until you and we attain that position."

The Ohio Electrolytic Oxygen Co., Cincinnati, Ohio, has purchased property adjoining its plant, and will erect an addition within the year.

* * *

The Bartlett-Hayward Co., Baltimore, Md., will erect for the U. S. Industrial Alcohol Co. at Curtis Bay, Md., a steel storage tank 43 ft. high and 59 ft. in diameter.

Outline of Lime Manufacturing Operations

By Major E. Holmes, Ph.D.

Manager, Chemical Department, National Lime Association



MAJOR E. HOLMES, PH.D.

Manager, Chemical Dept.,
National Lime Association.

cal engineering skill, shown in the accompanying illustrations.

The manufacture of lime is now one of the larger of our essential industries, operating efficiently under technical control and producing more than 3,000,000 tons of lime a year, which finds use in over one hundred industries.

The product, obtained by heating limestone to its dissociation temperature under such conditions that its carbon dioxide and other volatile constituents are expelled, is known as lime. It consists primarily of calcium oxide, but may contain magnesium oxide, which in some limes range as high as 45 per cent. Small amounts of alumina, silica and ferric oxide and traces of other constituents also may be present. The physical properties of lime also vary through a wide range. The control of these chemical and physical properties of the lime and as a corollary the production of the various kinds of lime required to meet the demands of the various industries depend upon the selection of the limestone and the manufacturing process. I have aimed here to summarize the information upon the various operations employed in up-to-date lime manufacture. The sequence of operations is as follows:

Locating the Quarry

Extensive limestone deposits underlie much of the territory of the central and southern states and the Appalachian Mountain states, but it is only in a very small portion of this territory that economic conditions are satisfactory for locating a lime plant. It is necessary to locate the quarry where geologic investigation shows that there is in sight and is available a very large supply of limestone having the chemical and physical properties required for making high-grade lime. Many other factors, such as topography, transportation facilities, fuel supply, overburden and bedding of the deposit, must be given due consideration.

Stripping

In most cases the topography is such that it is neces-

sary before opening the quarry to remove an overburden of loose material, consisting of clay, gravel and weathered limestone. Depending on local conditions, stripping is done by hand-digging, plow and shovel, steam shovel, or by hydraulic methods.

Quarrying

As a result of the variation in topography and in the forms of limestone deposits several kinds of quarrying operations are used. If the land is level open-pit quarrying is the usual procedure, but underground quarrying may be desirable; if the deposit forms a cliff quarrying may consist of working back the cliff or of tunneling. The rock is loosened from the beds by steam shovels in a few quarries, but the usual procedure is by blasting. A small hole is drilled with a drill operated by electricity, compressed air, or steam power. The holes are then filled with powder and the stone blasted. In some cases shooting before blasting is practiced, which consists of enlarging the drill hole with a miniature blast. Black powder is preferred for soft stone, but 40 per cent. dynamite explosive is more effective in hard stone.

After blasting loose the rock it is necessary to reduce the larger stones to "one-man size." This is done by hand-sledging in some quarries; in others the large stones are shattered by drilling and blasting with dynamite. The stones are classified by hand-sorting, the "spalls" or chips being discarded. The selected stones are then loaded for transportation to the kilns, for which operation wheelbarrows, carts or cars drawn by horses or cables, locomotives, or aerial buckets may be employed. Derricks are used in deep quarries to elevate the stone to the surface.

Crushing

In some quarries the blasting and hand-sledging is replaced by passing the stone through a large jaw crusher and then over a bar-screen. The crusher reduces the large stones to the permissible maximum size.

Screening

In some plants no screening is done, but in many, especially in plants employing mechanical crushing, the material discharged from the crusher is screened. The stone larger than five inches in diameter passes over the screen and is conveyed to the top of the standard shaft kiln in some of the ways mentioned above. The stone smaller than five inches passing through the screen may be disposed of in one or more of several ways. It may be conveyed to the limestone mill, where it is crushed or pulverized in ball or hammer mills and disposed of as aggregate or pulverized limestone without further treatment, or it may be screened to two finenesses, each of which is converted into lime, the finer portion in a rotary kiln, and the coarser portion in specially modified shaft kilns. These kilns are special recent modifications of the standard shaft kilns, designed to handle smaller stones than the latter; but as yet few plants have them in operation.

Burning

In the lime industry the term "burning" is used to indicate the process of calcination, whereby the lime-

stone is decomposed into lime and carbon dioxide. The chemical reaction involved in the decomposition of the limestone is a reversible one, requiring a certain minimum temperature, time of heating and partial pressure of the carbon dioxide. These conditions are realized most effectively in the standard continuous vertical-shaft kiln. These kilns are vertical steel shells about 10 feet in diameter and 36 feet high, lined with fire-brick. They are fired from the sides near the bottom, the flame only coming in contact with the stone. Coal is the usual fuel, but producer gas, natural gas, fuel oil and wood also are used. With good bituminous coal a ratio of one ton of fuel to four tons of lime is obtained. About 10 tons of lime per kiln per day are produced. Skilful operation of these kilns under technical control produces a lime free from ash, free from "core" or undecomposed limestone, free from overburned or sintered lumps, free of fused calcium compounds, and sufficiently inactive to be shipped without excessive air-slaking and sufficiently active to perform the functions for which lime is used in the various industries.

Kilns other than the standard shaft kilns have a proper place in the lime industry. In processes such as sugar manufacture, where the carbon dioxide is used, an improved type of pot-kiln serves the purpose. These differ from the standard shaft kilns in that there are no side fire boxes, but the coke is mixed with the limestone, which is fed in at the top of the kiln. The use of coke in this manner eliminates smoke and tar, and enriches the exit gases with carbon dioxide.

For the burning of oolitic limestones and others that shatter in the burning rotary kilns have given satisfaction. They also have a logical place for the burning of small stones and dust in those plants where small stones are not used for aggregate or pulverized limestone. For the latter use one rotary kiln per 24 shaft kilns has been found to be a satisfactory ratio. These kilns are usually about 8 feet in diameter and 125 feet long, fired with gas or fuel oil, and rotated mechanically. The stones slowly flow down the kiln, from which they drop as lime into rotary coolers and then into mechanical hydrators in case hydrated lime is to be made.

Another type of kiln now coming into use is a continuous-discharge, enlarged vertical-shaft kiln, designed to handle stones much smaller than the standard shaft kiln. The indications are that they are economical both in fuel consumption and in the utilization of the quarry product.

As stated above, most of the lime produced in this country is made in the standard vertical-shaft kiln. The process is continuous. The coarse stone from the screen or direct from the quarry is conveyed by cable cars to the reservoir at the top of the kiln and dumped into it. By the withdrawal of lime at the bottom of the kiln, which operation takes place at frequent intervals, the mass of stone is made to move downward in the kiln, the flame from the fire boxes on the side of the kiln passing up through the moving mass of stones. The design of the kiln is such that the flame is distributed uniformly through the mass, thus avoiding underburning in some sections and overburning in others. The stones pass from the reservoir to the pre-heating zone, where waste heat from the calcining zone below is utilized to pre-heat the stone. The section of the kiln immediately above the fire boxes is the calcining zone, where the stone is completely decomposed. The red-hot lime then passes down into the cooling zone, which is an inverted cone arranged for free circulation of air around it.

Drawing

The partly-cooled quicklime is drawn from the kiln by opening the horizontal doors that close the circular vent at the bottom of the cooling cone of the kiln. The intervals between drawings vary at the plants using various kinds of stones and making various kinds of lime. Lime is usually drawn every 3-6 hours, but sometimes every hour, and in some cases as infrequently as every eight hours. In some cases the lime drops directly upon the floor, where it is spread out to cool; in others it is discharged into cars, and in other plants it falls upon a mechanical conveyor, whereby it is moved forward to the next operation.

Grinding and Packing

After cooling the lime which is known as lump, rock, stone, or quicklime, is disposed of in various ways. It may be barreled for shipment in lump form. Much lime, however, is shipped in bulk in box cars.



Kiln Unit of a Model Lime Plant.

In such form the deterioration is surprisingly low. Data on 1,400 cars shipped from a point in central Indiana to a point in central Ohio, extending over all seasons of the year, showed an average increase in weight of but 1.30 per cent.

The lump quicklime frequently is pulverized and bagged either immediately or after an indefinite time in moisture-proof storage bins. In some plants it is the practice to remove the very fine material after pulverizing and bag the coarser portion, which is disposed of as granulated quicklime. A third kind of disposal of the quicklime is to hydrate it.

Hydration

The hydration of quicklime is one of the newer developments in the lime industry. At the present time about one-fifth of the lime produced in the country is hydrated.

The quicklime to be hydrated is crushed by gyratory crushers to 1-inch size or less and conveyed, usually by mechanical conveyor, to an apparatus that provides for supplying the lime with the proper amount of water at the proper rate and under the proper conditions of temperature and mechanical agitation to convert it into a hydrated lime of the required chemical and physical properties. By grinding the lumps more thorough hydration is effected in less time and a more uniform product is obtained. In some plants only the fine dust, which is removed from the granular lime

by air separation or screening, is hydrated. The amount of water supplied should be sufficient to convert all the bases to hydroxides and compensate for the steam evolved, but it should not be greatly in excess of this amount. If the temperature is too low the hydrating action does not go to completion; if too high the lime is "burned," whereby its chemical activity is seriously affected.

Three types of hydrators are in use, differing in principle, but all providing for the required conditions as specified above and for delivering the hydrated lime in the form of an extremely fine and dry powder. In one type the lime is turned over and over with small plows, the water being sprayed on top of the lime. In another type the lime is moved by screw-conveyor through a horizontal cylinder, it dropping from the end into another cylinder beneath, where the process is repeated, the movement of the lime being in the opposite direction.

material in the preceding operations. Carbonate, silicate and other materials in lump form, including unhydrated quicklime, are removed. A vibrating wire screen set at slight angle serves the purpose.

Finishing

To supply the demand for an extremely fine hydrated lime in certain very special uses, it is finished for the market by reducing it to a pulverulent condition by combined milling and air separation processes or by the use of tube or roller pulverizing mill.

Storage and Bagging

Elevators convey the dry hydrated lime to tight storage bins. From the bins it passes by gravity to automatic bagging machines, which pack the hydrate in paper bags of 50 pounds each. Each bag is weighed automatically, the weighing serving to actuate the valve controlling the flow of the hydrate into the bag. The



Construction and Operative Features of a Modern Lime Plant.

The cycle is repeated once, thus requiring four cylinders. The water is fed into the system in the top cylinder usually through the vertical condensing stack attached to the top cylinder. This latter type of hydrator is continuous, whereas the first type is intermittent. The hydrating process, as well as the process of burning the lime, requires the supervision of skilled and experienced operators. Every kind of limestone requires a special modification of the processes in large or small degree, as determined by its physical and chemical properties. Some limes containing a considerable percentage of magnesia require very special hydration processes in order to hydrate the magnesia.

Ageing

In a few plants the hydrate is aged. In this case it is discharged from the hydrator as a slurry into a concrete bin or silo, where it is seasoned with moisture and heat for a time sufficient to effect complete hydration. The heat liberated in the chemical reaction between the water and quicklime is sufficient, in a properly constructed silo, to attain the required temperature. The conditions can be made such that the hydrate, when removed from the silo, will be a dry powder.

Screening

Screening of hydrated lime is generally practiced. This serves as a check in the removal of unsuitable

automatic bagging serves not only to turn out a package of uniform and standard weight, but it makes working conditions much more satisfactory in that it eliminates the need of working in a cloud of lime, which would be the case if bagging were done by hand.

Uses

Lime in its various forms is shipped into all parts of the country to supply the demand in the agricultural, construction and chemical industries. Hydrated lime and powdered quicklime are usually shipped in paper bags, but cloth bags and tight barrels have been used. Lump quicklime is usually shipped in bulk form in box cars or in wooden barrels. Granulated quicklime is shipped in cloth bags. Pulverized limestone and crushed stone are usually shipped in bulk.

In agriculture hydrated lime, granulated quicklime, lump lime and pulverized limestone are used chiefly for correcting soil acidity and toxicity. In construction work lump quicklime and hydrated lime are used in making mortar, plaster, etc. Its usefulness in construction depends primarily upon the capacity of lime to make a putty with water which will set or harden on exposure to the air.

In the chemical industries lime finds use in over 100 manufacturing processes. Its usefulness in the chemical industries depends upon a large number of valuable properties, of which may be mentioned the following:

It is the cheapest base known; it is a saponifying agent; it is a coagulating agent; it will neutralize acids; it is a highly reactive chemical; it is very refractory; it will absorb gases; it will causticize; it will salt out material from solution; it is of slight solubility in water; it is a pigment; it is a high temperature lubricant; it is soft in texture; it is a clarifying agent, etc.

This article gives in brief outline the various

processes in lime manufacture which are in use and approved by the country's large lime producers. The magnitude and importance of the industry, not only as providing an essential raw material to the chemical and allied industries, but by being, in its most efficiently conducted types, a chemically controlled industry, warrant the place that lime manufacture is taking in the industrial activities of the country.

Interpretation of Boiler-Water Analyses

By J. R. McDermet

Research Engineer, Elliott Company

THE chemist in performing a technical water analysis proceeds along conventional methods and by processes of evaporation, selective solution, precipitation, etc., determines quantities which he may submit for consideration directly, calculate into terms of elemental ions and ion radicals, or hypothesize into various chemical compounds which are assumed originally to have existed in the water. Irrespective of how results are submitted it is possible to calculate back into ion values, to which may be applied certain generalizations—with the reservations, however, that the values are arrived at initially by inflexible methods and are connected with the properties of the water only through deductive relationships.

The dissolved chemical compounds of a water which will ultimately become scale on the boiler surface are relatively slightly soluble in a physical sense. Chemically they are characterized as feebly hydrolyzed salts, and as such they are capable of very little dissociation in water—and then only into a very limited number of ions or electrified particles: namely, those of the salt itself and those of the dissociation with water.

Corrosive salts, on the other hand, are characterized as being both hydrolyzed and highly ionized, one of ions at least being that of a strong acid or base. If the chemist's ionization constants are applied to a group of these salts representative of a natural water, a bewildering series of relationship develops, due to the number of ions and their mutual effect in displacing the equilibria of each other.

Such a procedure, however, is irrational for three reasons: (a) Ionization constants are experimental factors determined for normal temperatures only and are not necessarily valid at boiler temperature. (b) The water molecule is of the form $(H^2O)_x$, and water in its transition from liquid to superheated steam undergoes a change of molecular grouping from the dihydrol into the monohydrol form. This transition is not abrupt at the change of state, but gradual with rise of temperature. The monohydrol form which exists in small proportions at normal temperatures apparently occasions both the hydrolytic and dissociation phenomena. (c) Concentration of impurities in a boiler operating at high rating and high circulation velocity varies widely at different points in the circuit, the concentration increasing at regions where the water is abruptly accelerated. The rule of experience alone is applicable to these classes of impurities.

The laboratory-procedure outline appearing later in this paper* employs the following basis of distinction: The values obtained in the analyses are computed into those compounds which form scale as far as the analytical values suffice. In this grouping abnormal silica is the only constituent which is capable of causing

corrosion and its action is mechanical in permitting local over-heating. To the remainder of the impurities limiting values are assigned, either on a percentage or an integral basis, the integral values being reserved for those constituents which are virulent.

Sodium is ordinarily a fictitious quantity employed to balance combinations, but if the water analysis indicates a possibility of danger according to the criteria employed, a real value of sodium is determined and compensation is allowed for its presence. Sodium is so strongly basic in its chemical properties that its behavior in solution can be predicted with some exactness, and the hydrolyzed products of sodium salts are themselves inhibitors of corrosion.

It is only the relatively pure waters which produce dangerous conditions, and as the sum of dissolved solids decreases, the liability toward corrosion disproportionately increases. Beyond an impurity content of 300 parts per million, corrosive waters are almost invariably of abnormal chemical analysis so that the danger is immediately apparent. Below 50 to 60 parts per million, the technical analysis, even if it shows no unfavorable features, is usually sufficient unless the history of the origin of the water is definitely known. For such waters a sanitary analysis is a distinct contribution.

The Sanitary Analysis

The sanitary analysis is more truly a series of tests in which the reaction of the water is observed as indicative of the pollution which it has undergone, than a determination of foreign constituents. Technique has been so highly developed by the sanitary chemist that it is possible for him to tell from the values obtained in analyses the extent of the pollution and its sources—whether they be industrial, organic vegetable, or wastes from animal or human sources.

Industrial pollution usually manifests itself in the form of some characteristic compound which is a by-product of processes of manufacture. Aside from mine and paper-mill wastes, which usually reveal themselves unmistakably in the technical analysis, this class of pollution may occur in extreme dilution and yet be harmful in pure waters.

Under the heading of organic vegetable contamination may be grouped the products of algal growths, water plants in stagnant bodies of water, and the runoff from uncultivated land, particularly marshes, and deforested or forest fire areas. Chemically such contamination manifests itself either as acidity due to weak organic acids, or as nitrogen compounds.

In the power plant the physical damage resulting from organic acids appears principally in the corrosion of saturated-steam lines, turbines, and vapor spaces of condensers; in other words, in apparatus where moisture accumulates from partial condensation. Unlike

* Presented at the spring meeting, Chicago, May 23-26, of The American Society of Mechanical Engineers.

dissolved-gas contamination, the feed lines and boilers where the dilution of the acids is very great are reasonably exempt, and the corrosion does not exhibit its greatest vigor in a narrow zone of temperature. Undoubtedly the presence of dissolved oxygen accelerates the corrosion, but the organic acids polymerize or change their form rapidly and the action is not indefinitely cyclic as in the case of some mineral acids.

Nitrogen compounds, in particular ammonia, originating in organic vegetable pollution confine their attacks principally to copper and brass fittings and the iron is exempt in the path of steam flow. In dead-end spaces serious corrosion may occur on both ferrous and non-ferrous metals, but aside from this the damage is usually inconsequential. Dissolved carbon dioxide in appreciable concentration due to bicarbonate alkalinity accelerates corrosion.

Sewage contamination may be classified as recent or remote, and further divided into household refuse and animal or human excrementitious matter. The latter, unless it exists in a quantity that contributes a dangerous chlorine content, sludges in the boiler and may be dismissed without further comment. Oleaginous matter and greases from household wastes, if of recent origin, contribute to foaming, priming and corrosion much as do organic acids if in considerable concentration. Sewage of remote origin which has been oxidized by aeration and bacterial action shows high nitrate content and sometimes nitrites, depending upon the extent of the natural purification. While the criteria in such cases are the nitrate content and the qualitative presence of nitrites, the introduction of both of these into a boiler water in any concentration is earnestly to be avoided.

The Dissolved-Gas Analysis

The analysis for dissolved gases is confined entirely to the determination of dissolved oxygen. The position of dissolved carbon dioxide is anomalous. The researches of the author have been concerned with the simultaneous removal of carbon dioxide and oxygen, and are inconclusive; the published results of Speller¹ incline to the view that carbon dioxide in the absence of oxygen is not prejudicial. Cases where corrosion directly chargeable to carbon dioxide has occurred have usually accompanied a high-bicarbonate alkalinity or been complicated by ammonium compounds. It is probable, however, that increased rates of driving will compel an entire reversion of attitude toward boiler-water alkalinities.

Dissolved Oxygen

Analytical methods for determining dissolved oxygen are available in standard chemical textbooks, and methods of manipulation adapted to the engineer's needs have been discussed in the technical press. Methods for determining dissolved oxygen fortunately, and unlike other analyses on water, determine definitely and directly the constituent sought, and it only remains to apply the information intelligently to the elimination of corrosion problems.

While deterioration of the ferrous metals results at all stages of the water and steam cycle where water and oxygen are present as such, in all but two cases which have developed in the writer's experience alleviation has been sought only for steel-tube or cast-iron economizers, boilers, or hot-water feed lines. The characteristic manifestation is the wasting of cast iron

and pitting of steel surfaces, sometimes accompanied in the latter cast by a pseudo-stalagmite formation.

It is impossible with commercial pipe materials to formulate an opinion as to how long a hot-water boiler-feed pipe system will last. It appears, however, that if the oxygen content is kept below 0.7 cc. per liter (0.7 part in 1,000 by volume), the gas volume being reckoned under standard conditions, the life of the feed lines will be of such a length as to prevent ascribing the ultimate failure to oxygen. It may be taken as axiomatic, however, that the reduction of oxygen content to the lowest consistent value is always a desirable precaution.

Boilers that operate below rating rarely suffer any damage, whatever may be the oxygen content of the feedwater. As the rating goes up, however, damage appears, but if the concentration is kept below 1.0 cc. per liter the boiler seldom experiences pitting action. Boiler scale is a fairly efficient protective agent against this form of attack. Unfortunately, scales of predominant silicate or pure sulphate composition introduce a different corrosion loss, in that there is an amalgamation at the boundary between the iron surface and the scale through the intermediation of iron oxide.

The use of mechanical tube cleaners in removing this scale results in a severe detrition loss from the iron surfaces which may very markedly shorten the life of the boiler. The removal of oxygen from the boiler feed to the extent that existing apparatus is able to accomplish it, does away with this amalgamating action, and these classes of impurities in the absence of heavy carbonate formations become self-scaling.

Boilers rarely present simple corrosion phenomena. Usually trouble arises from a complexity of causes. Corrosive dissolved solids which yield free acid radicals and dissociated acid radicals and dissolved oxygen are mutually accelerants of pitting action. With such boiler waters the removal of dissolved oxygen is a worthwhile alleviation and a guarantee against regenerative action with a stable acid iron, but it is not a cure.

Chemical treatment of the water is the most logical corrective if it is properly controlled and is not based on excessive alkalinities; but in practice the results obtained are usually far short of the ideal and need to be supplemented. The pitting of the surfaces presents the same general appearance. Where it is directly chargeable to dissolved gases the action is more or less selective, in that the area of greatest virulence is confined to parts where the circulation is sluggish, and entirely to the water space.

Cast Iron Economizer Corrosion

The corrosion of a cast-iron economizer likewise presents two aspects. The corrosion of cast iron in its initial stages is more rapid than that of steel, but the adhering residue products from the corrosion—graphitic carbon and silica—immediately form a protective coating which arrests further action. Cast-iron economizer corrosion is due to the continuous removal of the protective coating, has most nearly the appearance of erosion, and takes place in the headers and tube ends where water velocities are changed. This erosive-corrosive action will disappear if the oxygen content of the feedwater is kept below 0.7 cc. per liter, provided that the water does not deposit scale on the economizer surfaces.

Economizers in the past have been principally waste-heat adjuncts operating between the extreme temperature limits of 90-250° F., and of these limits are extended in future practice it will doubtless be neces-

¹A Method for Practical Elimination of Corrosion in Hot Water Supply Pipe, F. N. Speller, *Jour. Am. Soc. of Heating and Ventilating Engineers*, vol. 23, no. 9, January, 1917.

sary to lower further the oxygen value. Where the temperature and character of water combine to produce scaling on the cast-iron tubes which necessitates the periodical use of mechanical tube cleaners, the safe oxygen limit is automatically reduced to 0.3 cc. per liter. The tube cleaner not only removes the existing protective coating which has formed, but disturbs the surface layer so that a new one is slow in forming.

Jacobus and Speller independently and by different methods have established the value 0.2 cc. as the maximum oxygen content which will prevent accelerated corrosion in a steel-tube economizer. The allowable content which will permit the realization of a profitable operating life from the economizer may conceivably be lower than 0.2 cc. per liter, but this can be determined only after years of experience.

Steel Tube Corrosion

The most virulent steel-pipe corrosion occurs between the temperature limits 180-200° F.; and no such range is exhibited by the steel-tube economizer. Water in its passage through and temperature elevation in the economizer gradually rejects a portion of its dissolved gases in the form of bubbles which cling to the tube wall and by coalescence establish for themselves a slower rate of travel than the water, whose velocity is materially below the region of turbulent flow. Besides materially reducing conductivity, these bubbles through their oxygen-content both occasion the corrosion and distribute it over the entire surface.

The characteristic corrosion phenomena in the case of steel-tube economizers are pit holes. The primary cause for these may be exceedingly small pieces of imbedded mill scale or segregated impurities in the metal which form electric cells and occasion roughness, or an initial roughness on the surface to which the bubbles of gas adhere and produce minute air pockets. The appearance of a pit hole is accompanied by a stalagmite or barnaclelike growth of corrosion products completely covering the pit hole and projecting above the surface.

These barnacle-like protuberances consist of three successive layers of iron hydroxides in the order of their proximity to the iron surface, $\text{Fe}(\text{OH})_2$, $\text{Fe}_2(\text{OH})_6$, and $\text{Fe}(\text{OH})_3$, which in their dehydrated forms correspond respectively to the ferrous, black, and red oxides of iron. The hydroxide $\text{Fe}_2(\text{OH})_6$ only is adherent, and constitutes the binder and the bulk of the volume. The growth of these projecting surfaces further arrests the bubbles and the electrolytic potentials accelerate the action, but all causes combine to keep it very localized. The result is a punctured surface.

Laboratory Procedure

I. If the water originates with the Condenser Division as a water for circulation, perform (7), calculate according to (8), and report on this basis.

II. If the sample originates with the Air Separation or Research Divisions, perform the analysis according to the detailed procedure which follows. A memorandum from the chief of the division concerned will be issued covering as far as data permit the following facts:

- Purpose of the analysis;
- History and origin of the sample;
- Any physical observations which would direct a preponderance of suspicion toward peculiarities to be expected in the analysis.

III. Record all numerical results in parts per million. (p.p.m.)

IV. Record from observation in clean glassware qualitatively:

- Turbidity
 - Presence of visible suspended matter
 - Color
 - Odor hot
 - Odor cold
- V. Determine by titration:
- Acidity; (b) Alkalinity to phenolphthalein; (c) Alkalinity to methyl orange.

VI. Calculate from (5):

- Acidity as minus CO_2 ; (b) Alkalinity as plus CO_2 ; (c) Causticity as (OH).

VII. Analyze and calculate:

- | | |
|--|--|
| (a) Suspended matter. | (i) Silica |
| (b) Total dissolved solids | (j) Sulphates |
| (c) Loss by ignition (indicate qualitatively if there is any blackening of the residue during heating) | (k) Chlorides |
| | (l) Nitrates (nitrometer) |
| | (m) Ammonium (free) |
| | (n) Bicarbonates (HCO_3) |
| | (o) Carbonates (CO_3) |
| (d) Inorganic dissolved solids | (p) Hydroxides (OH) |
| (e) Calcium | (q) Calculated inorganic dissolved solids (sum of (7-e) to (7-p) inclusive). |
| (f) Magnesium | |
| (g) Aluminum | |
| (h) Iron and manganese as iron | |

VIII. When hypothetical combinations are required, calculate as follows and make out a careful balance sheet:

- Iron, magnesium and aluminum as sulphates
- Calcium as carbonate
- Any remaining calcium as sulphate
- Any remaining calcium as nitrate
- Any remaining calcium as chloride
- If any carbonate remains, calculate as much of the available magnesium to carbonate as possible.
- Any remaining magnesium to sulphate
- Any remaining magnesium to nitrate
- Any remaining magnesium to chloride
- Any remaining anions to corresponding sodium compounds, the value for sodium being assumed
- Express silica as such

IX. Apply to (7) and (8) the following criteria:

- If the silica exceeds 5 parts per million (p.p.m.) and the causticity 30 p.p.m., report as industrial pollution and discontinue. If silica exceeds 5 p.p.m. and the causticity is low, report as having passed through sanitary filtration for verification.
- If the calculated inorganic dissolved solids (7-g) are less than 60 p.p.m. or acidity is indicated under (5-a), determine acidity or alkalinity by an electrometric titration and report as (9-b).
- If the calculated inorganic dissolved solids (7-g) lies between the limits 60-300 and the sum of (8-b), (8-c), and (8-k) is less than 60 per cent of this total, or if (7-k) exceeds 25 p.p.m. or (7-l) exceeds 10 p.p.m., determine a real value of sodium-potassium and report as sodium under (9-c).
- If the calculated inorganic dissolved solids (7-g) exceed 300 p.p.m., discontinue.
- If the sum of the calculated inorganic dissolved solids (7-g) is less than 60 p.p.m., apply the sanitary analysis which follows.

X. Determine:

- Oxygen consumed by permanganate on two samples within the temperature range of 60-80 deg. Fahr., one at the end of 15 minutes, one at the end of 3 hours.
 - Nitrites (qualitatively)
 - Nitrates (transfer (7-l))
 - Free ammonia
 - Albuminoid ammonia
 - Kjeldahl nitrogen
- XI. Interpret the limits as follows:
- Oxygen consumed: High = 4 p.p.m.; low = 0.6 p.p.m.
 - Nitrites (qualitatively): High, distinct, faint, very faint trace, none
 - Free ammonia: High, 1 p.p.m.; low, 0.1 p.p.m.
 - Albuminoid ammonia: High, 0.2 p.p.m.; low, 0.02 p.p.m.
 - Nitrates: High, 10 p.p.m.
 - Chlorides: High, 25 p.p.m.

XII. Apply the limit of (11):

- | Free Ammonia | Albuminoid | Chlorine | Inference |
|--------------|------------|----------|------------------|
| (a) High | Moderate | Low | Sewer gas |
| (b) High | High | High | Sewage |
| (c) High | Low | High | Human pollution |
| (d) Moderate | Low | Very low | Vegetable matter |
- High oxygen consumed, particularly in the presence of low acidity, is confirmatory of sewage.
 - If the albuminoid nitrogen is approximately one-half the Kjeldahl nitrogen, it is confirmatory of high organic purity. If it is appreciably greater than one-half, it indicates pollution.

Industrial Education for Rochester's Industries

By J. Ernest Woodland

Director, Department of Chemistry, Mechanics Institute of Rochester

IN meeting the educational requirements of young men and women of the industrial region of Rochester who desire quicker entrance into industry than is permitted by the university and the advanced technical school, the Mechanics Institute of Rochester has performed an invaluable service to the community and its industries, and has justified fully the vision of our local manufacturers and employers, who 35 years ago initiated its establishment in the following statement:

"We consider the establishment of free evening schools in this city for instruction in drawing and other branches of study as are most important for industrial pursuits, of great advantage to our people. We believe that, besides the immediate benefit these schools would bring to many, they would greatly assist in gradually securing to our city the technical instruction and training which brings so valuable and beneficial results wherever it exists, and which is admitted to be of vital interest to our country. We consider it proper that our manufacturers and employers should take the first steps."

All who are familiar with Rochester's affairs of three decades back will know that the author of many plans for the public good—the man to whom the inception and largely the extension and upbuilding of Mechanics Institute is due—was Capt. Henry Lomb. Others who efficiently furthered the work by counsel and contributions were Hiram Sibley, James W. Gillis, Wm. S. Kimball, William H.



J. ERNEST WOODLAND

Director, Department of Chemistry, Mechanics Institute, Rochester, N. Y.

efficient workers and in many instances are later advanced to the position of superintendents.

The two-years' course in chemistry is designed to meet the needs of those who desire to become superintendents and managers of industrial plants wherein chemical processes play an important part. The course is intended to acquaint the student with the general field of chemistry, to provide the theoretical foundation requisite for his professional career, to give him technical skill and to develop his ability to carry on enterprises requiring chemical knowledge.

This course, though brief, gives the most important essentials of technical chemistry. Chemical analysis, both qualitative and quantitative, lead to general industrial chemistry, and a large portion of the second year is given to experimental work of a special nature in the chemical laboratories.

The young men completing this course are not sent out as chemists, but rather as trained assistants who will take their places in the chemical industries under heads of departments in such industries Eastman Kodak Co., Bausch & Lomb Optical Co., Taylor Instrument Co., steel and iron industries, city engineers' laboratories and other positions requiring chemical knowledge, the purpose of the course being to make them familiar with methods employed in modern laboratory practice and to give them an opportunity to develop technical skill. The value of an educational institution of this character to the industrial progress of



Mechanics Institute, Rochester, N. Y.

Walker, Don Alonzo Watson, Ezra R. Andrews, A. M. Lindsay, Henry Michaels, L. P. Ross and George Eastman.

Mechanics Institute is an endowed polytechnic institution providing, as regards the needs of Rochester's industries, instruction in chemical, electrical and mechanical engineering, whose graduates immediately enter the various industries, becoming



Laboratory of Industrial Chemistry, Mechanics Institute

the community is evidenced in its support by our leaders in manufacturing and trade. In a recent endowment drive for \$200,000, the chief employers of our technical graduates contributed as follows: Bausch & Lomb Optical Co., \$25,000; George Eastman, \$15,000; Adolph Lomb, \$15,000; Carl F. Lomb, \$15,000. Carl F. Lomb is chairman of our Executive Committee, and Royal B. Farnum is administrative president of the Institute.

British Heavy Chemical Enterprise

THE Le Blanc process, a creation of French ingenuity during the embargoes of the Revolution which cut off France from supplies of kelp, was worked out on English soil by James Muspratt in 1823 and by William Gossage, who in 1854 first produced commercially solid caustic soda. A century later finds in the discard in the alkali industry a chemical process unmatched in influence on industrial progress.

Brunner, Mond & Co.

The recent financing of Brunner, Mond & Co., which by Sir John Brunner was instrumental in introducing in England the process of Ernest and Alfred Solway, who in 1863 in Belgium surmounted the mechanical difficulties of the process that bears their name, directs attention not only to the displacement by the Solway process of the Le Blanc process and of its present competition with electrolytic caustic, but to the world-wide ramifications of this historic organization.

Its chief plants are at Northwich, Cheshire, and at London, England. In addition to its manufacturing interests represented by Brunner, Mond & Co., China; Brunner, Mond & Co., Japan; and Brunner, Mond & Co., Canada, it is affiliated with Solvay & Co., Belgium, and the Allied Chemical & Dye Corp. through the latter's constituent, the Solvay Process Co. of Syracuse. The English organization controls Synthetic Ammonia & Nitrates, Ltd., which it formed to acquire from the government the site and material assembled thereon at Billingham-on-Tees, Stockton, for nitrogen fixation during the war. This plant for ammonia and nitric acid production by the modified Haber process is under construction, the company having obtained the license of the British Government, under the Peace Treaty to work the English patents of the Badische Anilin und Soda Fabrik, besides the British Government's inventions worked out by the munitions inventions department during the war.

A new alkali plant, employing the Solvay process, also is under construction at Northwich which is stated will be the highest achievement of chemical engineering applied to soda ash manufacture. The Lostock works at Northwich where during the war the company produced 80 per cent. of the ammonium nitrate output of the Kingdom have been reconstructed on modern lines.

Notable absorptions of the parent organization by the acquirement of financial control are the Castner-Kellner Alkali Co., the Electro Bleach & By-Products Co., Chance & Hunt, Birchenwood Colliery Co., Buxton Lime Firms Co. and other fuel companies, and mineral rights in brine-bearing land in Cheshire.

The total paid-up capital of Brunner, Mond & Co. aggregates £13,577,843 of which £9,577,843 is in common stock and £4,000,000 in preferred stock, including the recent issue of £2,500,000.

United Alkali Co., Ltd.

Integration in the alkali industry of Great Britain leaves only the United Alkali Co., Ltd., whose chief plants are at Widnes and St. Helens, with connections in America and Spain, as the only concern of any importance producing soda ash not allied with Brunner, Mond & Co., the history of which concern is inseparable with the development of the Le Blanc process.

How the United Alkali Co., Ltd., has adapted itself to the changing economic environment is best shown

by quoting the chairman of the board of directors, Max Muspratt, on the occasion of a recent stockholders' meeting at Liverpool. Mr. Muspratt said, in reference to general business and the effect of the recent miners' strike:

"We are watching the position with the greatest care, and adjusting our policy from week to week on experience and information; at the same time we are not giving way to panic, and are in a position to support consumers in every industry to facilitate their recovery at the earliest moment of increased demand

Present Position and Prospects

"At the present moment we have stopped completely several of the works, and partially stopped others. We had hoped that the transference from the older to the newer processes would have been more gradual and that various developments would have absorbed most of the workmen and all of the staffs. But this was impossible in present circumstances, and we have had, with regret, to give notice to a large number of men and are disbanding some of our staffs. It must not be thought, however, that the outlook is all gloomy. The overtaking of deferred repairs and the introduction of the newest processes are practically complete, and, in particular, the electrolytic plants are all in perfect order, as is our large power station at Widnes. These changes mark an epoch in the history of the chemical industry. For a century the Le Blanc process served the world, and by the enterprise and genius of our forefathers placed Great Britain in the forefront of the nations in the heavy chemical industry; a position she has never lost, though it has been challenged on many sides. Those who had been brought up in it felt a sentimental regret at the necessary changes, but looked to the future with confidence, knowing that the training the Le Blanc process gave was no small asset.

We are now producing on the best and most economical lines, and a comparatively small increase in demand, which must come as accumulated stocks of general commodities pass into consumption, will put the company on a sound basis of profitable manufacture.

The Widnes Brine Find

"The finding of brine in Widnes, by a happy chance pre-eminently suited for the process now installed, means an important improvement in the company's position, and since the beginning of this year we have been able to work our electrolytic plants practically entirely on our own brine. This development puts us on an equal footing with competitors in any part of the world; indeed, in some ways, in a superior position, as apart from the absence of brine Widnes was an ideal center for the chemical industry."

Lever Bros., Ltd.

The largest manufacturing corporation in Great Britain is Lever Bros., Ltd., which acquired from Brunner, Mond & Co. its interests in Joseph Crosfield & Sons, and William Gossage & Sons, both large soap manufacturers, under stipulations whereby Lever Bros., Ltd., agrees to buy soda ash from Brunner, Mond & Co., so long as it is able to supply it, and the latter agrees to refrain from engaging in soap manufacture. Both soap concerns mentioned also manufactured silicate of soda to which the restrictive stipulation does not apply.

Hercules Powder Co. Absorbs Aetna Explosive Co.

RECENT approval by the Federal District Court at Philadelphia of the acquirement of the Aetna Explosives Co. by the Hercules Powder Co. was followed by a formal meeting of the stockholders at the offices of the former company at 165 Broadway, New York, on June 6, who approved of the sale of the entire property, assets, privileges and franchises, etc., in accordance with a contract dated Feb. 12, 1921, made by and between J. S. Bache & Co., bankers, and Hercules Powder Co., Inc. The bankers now announce that the sale has been completed and that the proceeds of the sale have been received by them.

The consideration was \$5,400,000 in cash and \$2,160,000 in 7 per cent. cumulative preferred stock at par of the Hercules Powder Co., which the bankers will distribute to the holders of the common stock of the Aetna Explosives Co. as follows:

For each share of common stock the holder shall receive \$10 in cash and \$1.50 in the 7 per cent. cumulative preferred stock at par of the vendee and in addition thereto an escrow receipt for \$2.50 in such stock. The last mentioned amount of stock shall be held by J. S. Bache & Co. in escrow pending the liquidation and discharge of certain liabilities of the Aetna Explosives Co., all in accordance with the contract dated Feb. 12, 1921.

The Hercules Powder Co. takes the property, assets and business subject to a mortgage dated Jan. 1, 1919, made to the Bankers Trust Co. and now a lien on the property, and also subject to the unpaid outstanding bonds of the Jefferson Powder Co., and all the debts, contracts, liabilities and obligations, all of which are to be assumed by the purchaser as set forth in the contract. The actual recipient is the Hercules Explosives Corporation of New York organized for the purpose and whose stock is owned by the Hercules Powder Co., Inc., of Delaware.

This transfer marks the passing of the last considerable organization in the explosives field independent of du Pont affiliations. Organized in November, 1914, by A. I. Moxham, theretofore identified with E. I. du Pont de Nemours & Co., and whose son Egbert Moxham was the first general manager, the company acquired directly or through stock ownership the plants and properties of the Aetna Powder Co., Miami Powder Co., Keystone National Powder Co., F. K. Brewster, Inc., Jefferson Powder Co., Pluto Powder Co. and 60 per cent. of the stock of the Kingsley Wood Pulp Co., Salisbury, Vt. The Aetna Chemical Co., of Maine, and the Aetna Chemical Co. of Canada, Ltd., were incorporated as subsidiaries. The business comprised the manufacture of dynamite, black powder and explosives accessories, to which with the demand incident upon hostilities was added the manufacture of smokeless powder, T N T, picric acid and guncotton, contracts for which immediately were procured from the French, British and Russian governments.

In fulfillment of these contracts a smokeless powder plant and a picric acid plant were built at Emporium, Pa. Near Mt. Union, Pa., the Silverford farm was acquired and in a field of growing wheat was erected the smokeless powder plant.

The old Aetna Company's plant at Aetna, Ind., was turned into a gunpowder plant. Two plants were built near Pittsburgh, Pa., one at Oakdale for the manufacture of nitric acid which later was devoted to T N T and one at Heidelberg for T N T and synthetic phenol, which latter product was shipped to Emporium. A contract with the Bethlehem Steel Co. for tetranitro

aniline for filling shells for the Russian government called for the manufacture of this material at Nobles-town, Pa.

Smokeless powder under the British contract was made at Drummondville, Canada, where was produced most of the smokeless powder made in Canada for the British government. At the Irvine, Pa., plant was installed equipment for the production of benzol and toluol from petroleum by the Rittman process, an enterprise compelled by scarcity of these materials but which was unsuccessful.

Before the United States entered the war the company entered upon the manufacture at Carnegie, Pa., of benzoic and salicylic acids and aniline, which soon was abandoned for the manufacture of diphenylamine, which was continued until the company was able to buy it.

With the extended manufacturing operations under contracts some of which proved unprofitable and with a deficiency of operating capital, the entry of the United States into active participation in the war found the company in financial difficulties. Receivers, B. B. Odell and G. C. Holt, were appointed to take over and operate the business, who with the assistance of H. L. Wollenberg, their general manager, obtained from the War Department large contracts for smokeless powder, picric acid and T N T. The various plants resumed operation and with the cooperation of C. A. Bigelow, then assistant general manager; O. G. Pratt, chief engineer; C. H. Cordie, chief chemist, and others, the company was put on its financial feet in a program of production operation that contributed materially to the weight of American arms. About 40 million pounds of picric acid were produced, a quantity greatly in excess of that of any other source and turned out without a single accident. As much, however, can not be said of its huge production of T N T, for its experience with this material was marred by a disastrous explosion at Oakdale involving the loss of 100 lives and the loss of one and a half million dollars.

The armistice found the company engaged in the erection of a large T N T plant at Mt. Union, Pa., and a picric acid plant at Drummondville, Canada, which would have increased its output of the former to 2½ to 3 million pounds and of the latter to 3½ million pounds per month. Immediately all construction ceased, which was followed within ten days by the cancellation of all contracts.

The Aetna, Ind., plant made guncotton for the French government of such superior quality that not a single rejection was encountered. This plant and the Emporium, Pa., picric acid plant constituted the chief mainstays of the French forces during the crucial period of the early days of the war.

Picric acid was made by a novel process not theretofore employed. Extreme urgency of demand compelled discarding the use of small pots in the process as then generally practiced. Instead were used glazed-tile-brick-lined nitrotrators of a capacity that yielded 2,000 lbs. of picric acid per charge. At the request of the War Department the company permitted the use of this process by other explosives manufacturers. Ammonium picrate also was made at Emporium from picric acid and ammonia liquor.

Trinitrotoluene, T N T, first was made by the 1-stage process wherein tri-nitration was sought to be effected in one operation. Experience with the 2-stage process, producing mono- and trinitro- at the respective stages, demonstrated increased yields, which efficiency still further was increased by the conduct of

the procedure in three stages producing respectively mono-di- and finally trinitrotoluene. Owing to the close proximity of the Oakdale and Carnegie plants to habitations, the T N T was produced in the form of pellets, containing more or less water, and was shipped to Mt. Union where it was refined and grained at the Silverford plant.

Phenol was made exclusively at Carnegie first by the common sulphuric sulphonation and caustic fusion process, which the shortage of caustic soda soon made necessary its substitution by a greatly improved process involving the use of by-products obtained in early stages of phenol manufacture. Tetranitroaniline, invented by Bernard Flurschein, a naturalized British subject, was made at the Noblestown, Pa., plant, Mr. Flurschein being then director of the chemical and research division of the company, in larger quantities than elsewhere until the destruction of the plant in 1917.

Since the armistice the commercial powder business of the company has been good. A number of plants have been shut down and others abandoned or used only for storage, and manufacturing activity confined to those most strategically situated commercially. In the last class are the black powder plant at Goes, Ohio, the Jefferson commercial powder plant at North Birmingham, Ala., fulminate of mercury plant at Prescott, Ontario, the Pluto commercial powder at Ishpeming, Mich., the Brewster blasting cap plant at Port Ewen, near Kingston, N. Y., and the Emporium, Pa., commercial powder plant. The Howard plant at Em-

porium, Pa., is now devoted to muriatic acid and salt cake manufacture.

The administrative personnel of the company at the time of the transfer included Benjamin B. Odell, president; C. A. Bigelow, vice-president and general manager, and F. E. Fenton, treasurer.

Mr. Bigelow is a graduate of the University of Vermont and for long was connected with the Bayonne, N. J., plant of the General Chemical Co. The organization of Aetna Explosives Co., Inc., found him manager of the Pluto Powder Co. at Ishpeming, Mich., whereupon he was transferred to New York in charge of acid operations, serving later as assistant and finally as general manager.

The operating personnel embraces: F. P. H. Sholly, assistant general manager in charge of purchases and supplies; Sam. Rand, assistant general manager in charge of black powder plants; C. H. Cordie, general superintendent in charge of dynamite plants; Mr. Heddon, acting chief engineer; and F. K. Brewster, in charge of blasting cap manufacture.

The integration represented by the organization of Aetna Explosives Co., Inc., thus was one step to a later stride in the same direction in an important branch of chemical manufacture. The peace-time service of its constituents and the war-time service of the amalgamated organization constitute a contribution of no mean proportions to industrial and political progress. As a separate identity the book now is closed. After the fitful fever of war-time profits, it sleeps in the arms of Hercules.

The Menace of Prohibition to the Alcohol Using Industries

THE zeal of prohibition proponents to make more effective the National Prohibition Act indicates not only that much must be done in the way of popular education as to the place of chemistry in life and industry, but that at the present time it must be directed to those who would hamper the service of many essential industries by restrictions in the enforcement of legislation which is regarded by many as having run far ahead of public opinion.

No organic compound surpasses alcohol in indispensability and general use in the chemical and allied industries. In recognition of this fact and to promote the industries in which it is essential by making possible cheaper products, alcohol for use in the arts and industries and for fuel, light and power, made unpotable by denaturants, was declared tax-free by Congress in 1906.

The XVIII Amendment prohibits the manufacture, sale, transportation, importation and exportation of intoxicating liquors for beverage purposes, as does the supplemental National Prohibition Act, but which latter expressly excepts the legitimate use of alcohol for non-beverage purposes and made unpotable by denaturation, for which purpose about 50 formulas are employed according to the intended industrial use of the alcohol.

An important consumption outlet for alcohol is in the field of pharmaceuticals, perfumery, flavors, etc., for which legitimate use the undenatured alcohol is permitted under the supervision of the Internal Revenue Department.

Difficulties in the enforcement of federal prohibition many of which have become scandals in their glaring efficiency, have alarmed those who see in legislation a short-cut to moral development, for the success of federal prohibition. In the city of New York alone permits were granted for the manufacture of various

alcoholic preparations to 4,000 individuals and firms, which prior to "prohibition" never had been engaged in any business in which alcohol was used, while old established and reputable houses whose legitimate use of alcohol was well known were subjected to annoying and harmful restrictions in procuring supplies. The diversion of alcohol to illegal uses by irresponsible and dishonest concerns was permitted by enforcement agents to react to the discredit of law-abiding and reputable manufacturers.

The interference with legitimate industry by those charged with prohibition enforcement can be explained only on the ground of ignorance of the essential character of alcohol and of that official diffidence which seeks the path of least resistance regardless of consequences. The introduction by Mr. Volstead of Bill, H.R.5033, on April 25, as an additional supplemental measure in support of the XVIII Amendment, indicated such indifference to the best interests of the people as to arouse the entire chemical profession to what can be termed a political hazard to the chemical industry.

At hearings had before the House Committee in condemnation of the measure in so far as its provisions were harmful to the alcohol using industries, chemists and representatives of the industries received little more consideration from the political extremists in charge of the legislation than though they were actual and potential offenders of the law. In protest and in support of the best interests of the people, a meeting was held at Rumford Hall, New York, on June 6, on which occasion Dr. Milton C. Whitaker, vice-president of the U. S. Industrial Alcohol Co.; Dr. Martin H. Ittner, chief chemist, Colgate & Co.; Frank M. Boyles, chief chemist, McCormick & Co., Inc.; W. L. Crounse, attorney for the National Wholesale Druggists' Association, and Alfred D. Van Buren, counsel, legal

division, Internal Revenue Bureau, discussed the character of the proposed legislation and its harmful influence upon legitimate industry.

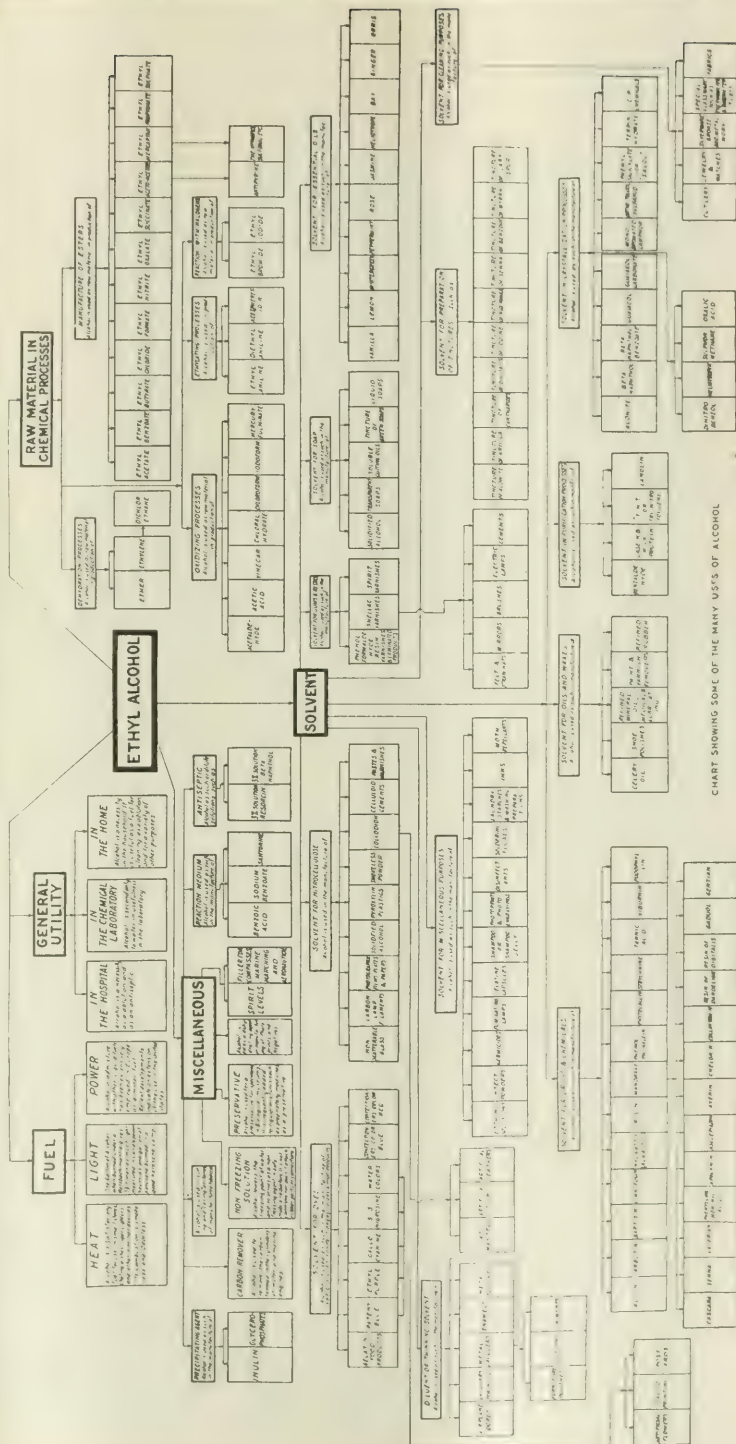
Chemists as a class not only recognize the fact that the enforced prohibition of alcoholic liquor is the greatest single step in social efficiency in all history and regard with sympathy the efforts of those who seek to make permanent the gains of society, but they resent that fanaticism that would pervert political power to compel legitimate industry to suffer from the inefficiency and worse of political administration of law that requires for its complete enforcement a generation of education.

Dr. John E. Teeple, president of the Chemists' Club, New York, in discussing the new Volstead bill at the Protest Meeting, said:

"The chemical industry of the country is united in favoring law enforcement. It is opposed to evasion of the Federal and State statutes. But when the Anti-Saloon League sponsors a bill striking at chemical industries the profession believes that the time has come to appeal to public opinion against such a vital blow at the manufacturing requirements of the country. The proposed bill is the result either of total ignorance of the whole progress of modern science or of a fanatical and ruthless disregard of public needs.

"The bill is a clumsy subterfuge, which, under the cloak of prohibition enforcement regulation, would permit of the destruction of many reputable and essential manufacturing industries without the right of appeal to the courts. It contains several 'jokers.' If enacted into law these 'jokers' would have far-reaching effects in crippling a great variety of chemical industries.

"While the public generally may be aware that the pharmaceutical preparations require the employment of alcohol, it is the province of the chemist to explain that alcohol has certain other very definite uses in an exceedingly wide range of industries. To the chemist, alcohol is not 'booze.' It is simply a chemical upon which he must rely for the production of innumerable essentials."



Report of the Executive Committee of the Manufacturing Chemists' Association for the Year Ending June 15, 1921

By Henry Howard, Chairman

IN the year that has passed since our last annual meeting we have had to face the most serious problems of after-war readjustment. A season of maximum production and prosperity was succeeded by a day when idle or part-time plants became distressing reminders of the halt that had been called upon industry. Concurrently with sharply diminishing domestic demand there appeared, further to aggravate our problems, the menace of ruinous competition from foreign countries whose goods, always produced at a much lower labor cost, could now be offered with the tremendous added trade advantage contained in the difference between the gold value of their currencies and ours.

This condition, not of our making, imperatively calls for relief and we have vigorously pressed upon the attention of Congress, which is pledged to enactment of remedial laws, the necessity for action that shall restore to our industry at least equal opportunities with our foreign competitors.

While mindful of the interests of the Association as affected by tariff and customs administrative legislation your committee has not failed to give careful attention to those matters of current concern which are no less important and many of which reflect the troublous economic and industrial condition of the time. This work, as well as the business at Washington receiving our attention, is progressing satisfactorily. Indeed, it is our conviction that in the successful outcome of a large part of our undertakings and in the encouraging stage of those now pending we can plainly see healthy signs of business recovery.

Affiliations

We have continued close relationship with the Chemical Foundation, Inc., and have maintained membership in the National Industrial Conference Board, the National Foreign Trade Council and the Chamber of Commerce of the United States. From each of these organizations we have derived distinct advantages during the year. Our relations with the Bureau of Explosives and with the Classification Committees of the railroads have been exceedingly satisfactory, and the matters that are now pending with them we believe will be acceptably worked out.

The committee has held regular monthly meetings throughout the year and several special meetings in addition, at all of which there has been practically a full attendance.

Tariff revision, always of vital concern to the chemical industry, this year takes on exceptional importance because of the chaotic conditions of world trade, necessitating consideration of such related subjects as American valuation of imports, interim legislation and provision for correcting the disparity in exchange. But in addition to the tariff there have been other legislative measures which directly affected the Association.

We have had for some time very agreeable relations with the Departments at Washington, and our business with them is constantly growing. On the part of some Department and Bureau Chiefs there is a growing purpose to place the facilities of their offices at the disposal of business and industry and your committee believes it would be to the advantage of the members to avail themselves of the opportunities when offered. It was

with this idea in mind that your committee voted to declare sympathy with the work of compiling production statistics about to be undertaken by Secretary Hoover of the Department of Commerce.

Legislation

In mid-summer of 1920 your committee began to formulate plans for presentation of recommendations for tariff revision. At the August meeting of the committee it was decided to call a special meeting in September to go over the rates in the chemical schedule of the existing tariff act, and to determine the most effective plan for making a thorough canvass of the tariff needs of the industry. At this September meeting it was decided to classify the Association membership into six group organizations according to the character of their products, and to request that they make a study of their tariff requirements for report at later meetings. That our decision in this regard was timely was confirmed by the announcement shortly after the election that one of the first acts of the new administration would be a revision of the tariff in accordance with the protection policy.

When Chairman Fordney of the Ways and Means Committee announced that hearings on tariff revision would begin on January 6 we were ready with an agreed statement of facts to present to his committee. The essential work had been completed by our group organizations at a series of meetings and when we met in Washington on January 4 and 5, the general brief of the Association and the individual briefs were ready for consideration and approval. Our members were the first to be called when the hearings before the Ways and Means Committee were formally begun on January 6.

During consideration of rates of the permanent tariff bill your committee also had in mind measures which might bring emergency relief to meet conditions arising from the disparity in exchange. Attention also was given to the danger from a flood of imports during the interim while the permanent tariff bill should be under consideration in the House and Senate, a period estimated from five to six months. After careful consideration it was deemed wise to suggest to the Ways and Means Committee enactment of a provision for the assessment of ad valorem duties based upon American valuation of imports. We also registered indorsement of a section that would give effect to the rates written in the permanent tariff bill immediately upon the date of its introduction in the House. As an emergency measure we also favored the House provision contained in the Farmers' Emergency Tariff Bill, which placed 66 2/3 per cent. as the limit of currency depreciation for the assessment of customs duties. That provision, as you know, was struck out by the Senate on the ground that it would create discriminatory rates as between foreign countries with widely fluctuating currency values.

By authority of your committee the Chairman presented a brief in support of the American valuation principle, and later he appeared by invitation of the Chairman of the Ways and Means Committee to make an oral argument to accompany the brief.

Opposed to our position in this matter were repre-

representatives of the Merchants' Association of New York, who strongly contended for existing methods of assessing valuation according to the foreign invoice. Since 22 members of our Association are also members of the Merchants' Association we challenged the right of representatives of the latter organization to commit our manufacturers to the recommendations they were urging. As the American valuation plan had been formally approved by the Association at the special meeting in Washington on January 5, your committee adopted a resolution which was filed with the Ways and Means Committee clearly setting forth our indorsement of the principle of American valuation and protesting that any representation of a contrary position alleged in our behalf was unauthorized and unwarranted.

The bill proposing an amendment to the Prohibition Act which, it was feared, would greatly restrict the use of industrial alcohol was brought to our attention and your chairman on May 17, before the Judiciary Committee of the House, pointed out several objectionable features. Later a brief was filed and a reply from Chairman Volstead, acknowledging its receipt, indicated that the provision against which objection was made would be materially modified.

In the 66th Congress, which expired on March 4, 1921, there were pending several bills which contained more than ordinary interest to the chemical industry. Chief of these was the so-called Nolan Patent Bill, H. R. 11984. This measure has been revived several times and undoubtedly you are all familiar with its provisions. Among other things, it undertook to give authorization to the Federal Trade Commission to accept assignment of patents from Government employees and to issue licenses at discretion, collecting royalties from the licensees for the benefit of the inventors. Our Association opposed this bill and joined with the organized industry of the country in pointing out the dangerous paternalistic character of its provisions. It passed both House and Senate and was referred to a conference committee, but the opposition was continued up to this last stage of legislation, and in response to a widespread petition for a hearing which theretofore had been denied the conference committee granted a hearing on January 5 to the opponents of the measure. Previous to the hour set a meeting was held of representatives of American industry, who designated your Chairman to conduct the hearing before the conference committee. So convincing were the many arguments presented to the conference committee against the bill, and especially that of Mr. Frederick P. Fish, that the Senate declined to receive the conference report, and the bill died.

We had also more than ordinary interest in the bills for development of the power plant and air nitrate plant at Muscle Shoals, Alabama, which likewise failed of enactment. These bills would commit the Government to participation in private enterprise for the manufacture of products in competition with some of our members.

In the closing days of the last session of Congress there was introduced a bill to extend the time for filing patent applications. This was a very meritorious measure and we unhesitatingly lent our support to it. It was passed on March 3 and signed by the President that night.

Department of Commerce

Several weeks ago Secretary Hoover of the Department of Commerce issued an invitation to the Associa-

tion for a conference to take up the question of collecting statistics on production, distribution and stocks on hand. In response to the call your committee was represented at a conference held on May 17th, at which time Secretary Hoover explained that it was his hope to collect statistics on production of four or five of the most important heavy chemicals and to arrange for circulation of the statistical information at frequent intervals for the benefit of the industry particularly, and ultimately for the advantage of business in general. Your Executive Committee by formal resolution declared sympathy with Secretary Hoover's plans and appointed a committee to co-operate with his department in carrying on the work. As a beginning it is planned to collect statistics on the production of sulphuric acid and nitric acid, soda ash, caustic soda and wood alcohol.

U. S. Tariff Commission

We have had occasion many times during the year to make use of the facilities of the U. S. Tariff Commission, and it is our belief that this agency of the Government can be of great value to the industry. Many useful publications have been issued by the Commission giving general and statistical information concerning the chemical industry, and these have been distributed to our membership. It is important to note that the reports made by the Commission of its independent investigations give substantial support to our claims for tariff protection and our recommendations for changes in customs administrative provisions. The Commission has shown a splendid disposition to be of service. Recent publications of the Commission on the subjects of American valuation, interim legislation and anti-dumping will be found in harmony with our recommendations upon those subjects.

Chemical Foundation, Inc.

Your members of the Advisory Committee of the Chemical Foundation have regularly attended the monthly meetings held in New York on the third Wednesday of each month and have actively participated in the business of the Foundation.

National Industrial Conference Board

Your delegates to the National Industrial Conference Board, your president and Chairman, are of the opinion that membership in that organization carries with it benefits to an extraordinary degree. The Board is composed of representatives from all the prominent industrial associations of the country and matters of general interest are considered in the light of scientific and carefully tested facts. The statistical work of the Conference Board on wages, living costs, and other industrial and economic subjects is acknowledged to be the most reliable of any issued either from private or public sources, and the Board's conclusions are universally cited as authoritative.

National Foreign Trade Council

The National Foreign Trade Council has been of material assistance to this Association. Several years ago our Association started the movements which resulted in the passage of the Webb Act permitting combination for export business—we carried the movement to a certain point when the financial burden became greater than we felt justified in assuming and the matter was then carried to completion largely through the efforts of the National Foreign Trade Council.

The result of this work has already been of great value to the alkali members of our Association and benefits are likely to accrue to other branches as well.

The National Foreign Trade Council is continually safeguarding our interests in foreign trade. Those interested in the subject are urged to read the Declaration of the last Foreign Trade Convention.

Bureau of Explosives

We have had considerable business during the year with the Bureau of Explosives and there are now pending many matters of importance under investigation which will be concluded upon the completion of the work by the several sub-committees having the matters in hand. The determination of a standard package for acid carboys is one of the problems upon which a joint committee composed of representatives of the Association, an official of the Bureau of Explosives and a representative of a glass manufacturer has devoted much time and careful thought. This committee has made a long series of tests and its report has just been received by your Executive Committee.

We also have special committees investigating the subject of specifications for steel drums, specifications for drums not to be refilled or reshipped, regulations covering shipment of niter cake, and a committee to investigate the maximum air pressure in unloading acid tank cars. Satisfactory determination of these questions is important because they have direct relation to costs.

Classification Committee

The Consolidated Classification Committee, representing the Official, Southern and Western freight territories, put forward last summer a suggested reclassification which would have imposed increased charges upon acid shipments varying from 50 to more than 100 per cent. Your Executive Committee appointed a special traffic committee to protest, in behalf of the Association, publication of the new classifications, and this committee presented the case for the industry at a hearing held in New York on August 30th last. Later a brief was filed and in response thereto the Chairman of the Consolidated Classification Committee requested an informal conference with the members of the traffic committee. At the conference assurance was given that no further action would be taken on reclassification until the points at issue had been given further study. The traffic committee is now working to obtain a modification of rules by which it is hoped to obtain a lower rate on returning empty carboys.

Membership Committee

Early in the year we appointed a membership committee and largely as a result of their work eight companies were elected to membership. We believe that if the advantages of membership in the Association were more generally realized there would be a marked increase in application for membership.

Administration Personnel

The following officers have been elected for the ensuing year: President, Charles L. Reese; vice-presidents, H. H. S. Handy and C. Wilbur Miller; treasurer, S. W. Wilder; secretary, John I. Tierney. The executive committee comprises Henry Howard, chairman; Adolph G. Rosengarten, Lancaster Morgan, C. Wilbur Miller, D. W. Jayne, H. H. Dow, and E. L. Pierce.

The Trenton Zinc & Chemical Co., manufacturers of zinc oxide, Trenton, N. J., will enlarge its plant. In 1920 it produced 2,000,000 lbs. of zinc oxide from ores mined at Salem, Ky.

New Jersey Chemical Society

The final meeting of the season of the New Jersey Chemical Society was held at Rutgers College, New Brunswick, where amidst the beautiful setting of New Jersey's state college members and friends filled the auditorium of the Chemistry Building.

Dr. Harlan S. Miner, chief chemist, Welsbach Light Co., Gloucester, N. J., delivered a lecture on the recovery of rare earths and their use in the manufacture of incandescent gas mantles. Dr. Miner's address was illustrated with slides and by an exhibit of rare earths and fabrics and a demonstration of relative illuminating efficiency of various rare earth compositions. Public interest in radium gave added interest to an exhibit of mesothorium obtained as a by-product in the recovery of cerium from the monazite sands of Brazil, which is the chief raw material of the industry, inasmuch as it is available for the same commercial uses as the radium salts.

Prof. John H. Logan, department of history, Rutgers College, discussed the background of the present labor situation in England and explained how the desire for equality of social conditions, following upon the attainment of political equality, dominated present English politics, and presented a picture utterly foreign to American ideals and institutions. Bolshevism and the English labor movement, he stated, differ only in the degree of force employed in the effort to establish communism, which in England is expressed in the demand for the nationalization of industry.

Prof. Logan, with notable circumspection, expressed no personal bias, but in the inferential contrast of conditions between England and America he enforced the conviction that democracy in industry will have no place in the individualism of American industry if the nation ever is to fulfill its destiny.

Motion pictures descriptive of the coal mining industry, Moroccan social conditions and—of especial appeal—the raising of babies, completed the regular program.

Dr. Frederick W. Zons, on behalf of the officers of the retiring administration, gracefully presented to Carleton Ellis a beautiful loving cup to commemorate the teamwork of the officers under his direction and its results in the growth and service of the society. At the conclusion of the program the members and guests repaired to Winant's Hall, where dinner was served.

The officers of the new administration are: Ralph G. Wright, director, department of chemistry, Rutgers College, New Brunswick, president; Charles P. Titus, consulting microscopist, East Orange, vice-president; Dr. Frederick D. Crane, consulting chemist, Montclair, secretary; and Sydney Davis, of Davis & Klaber Co., Newark, treasurer.

The board of governors embrace the following:

H. A. Curtis, chief chemist, International Coal Products Co., Newark; W. H. Gesell, general manager manufacturing laboratories, Lehn & Fink, Inc., Bloomfield; G. A. Armstrong, superintendent Grasselli Co., Elizabeth; E. J. Little, professor of chemistry, Rutgers College, New Brunswick; and Dr. F. D. Crane and Charles P. Titus.

The Tirrill Gas Machine Lighting Co., 50 Church St., New York, complains of the subterfuge whereby the prestige of the genuine Tirrill laboratory burner is injured by the substitution of another called a "style" or "type" of the phonetic original which has been marketed for many years. The genuine Tirrill laboratory burners are made only by the Tirrill Gas Machine Lighting Co.

Technology of Cellulose Esters

A Review of a Masterful Treatise on the History and Status of the Art of Manufacture of Nitrocellulose, Pyroxylin, Guncotton, Collodion, Artificial Silk, Lacquers, Viscose, Viscoid, Cellulose Acetate, Cellulose Ethers, Celluloid, etc.

By Lloyd Lamborn

THE magnitude and importance of any technical art are indicated by the number and nature of the patent and literary contributions which have been made on the various phases of the subject; are judged by the eminence of the investigators who have concerned themselves with its inception and development; and are measured by the ramifications and intricacy of the materials involved and their intimate bearing upon the necessities and luxuries of life. Perhaps no industrial chemical subject is of greater breadth and scope than that sought to be encompassed by Edward C. Worden in the ten volumes of his *Technology of Cellulose Esters*,* of which Volume I, exceeding 4,000 pages, is just from the press—Volume VIII, on the Carbohydrate Carboxylates (Cellulose Acetate), having been issued in 1916.

For ease of understanding and facility of reference, the five parts of Volume I of this great work have been divided into 12 chapters containing 637 main topics and 540 sub-topics, each complete in itself, the topics being so logically arranged as to form a connected whole. Each page consists of the more general information in large type, below which in the note portion is the detailed information, working formulas and references to additional or corroborative data in small type, the finer type constituting about sixty-five per cent. of the work. By this division of subject treatment, it is possible to obtain either merely a general idea by reading the large print only, or an exhaustive summary of the existing information for the specialist by attention to the finer print.

Part I, Vol. I, includes Cellulose, Starch and Cotton, which when combined with the Nitric, Sulphuric and Mixed Acids of Part II, constitute the foundation upon which the subject is afterwards amplified. Part III has to do with the theory, development, manufacture and testing of nitrocellulose for lacquer, leather, artificial silk, celluloid, pharmaceutical, photographic, explosive and other purposes, with charts, diagrams and 153 illustrations, the majority of which are full page. Part IV covers the almost endless commercial applications, and Part V in 623 pages, double and triple column, the Patent, Name and Subject Indices of the volume.

The general method of presentation and the succession of topics is indicated by the following synopsis, the number of pages allotted to a particular subject being



EDWARD C. WORDEN

shown in parentheses. Most of the chapters are books in themselves, so complete and exhaustive has been the treatment of the subjects dealt with. If this description appears unduly detailed, remember that a book review should be a review of the book sufficiently accurate and comprehensive to enable the reader to determine whether the probable information contained is of a nature sufficiently interesting or helpful to warrant the investment, and this has especial force in a work of this notable magnitude where the financial outlay required is correspondingly large.

Cellulose

The first chapter (Cellulose, 388 pages) opens with the classification of the carbohydrates and the constitution and commercial preparation of the various celluloses (30), with a discussion of the formulae of cellulose which have been proposed from time to time and their relative importance and bearing upon the practical side of the subject; methods for the formation and purification of celluloses for specific purposes, and including the colloidal properties and reactivity (16). The viscosity, optical properties and action of heat, light, air, tannins and dyestuffs upon normal and modified cellulosic bodies follow (20), the solvents as cuprammonium, hydrochloric and sulphuric acids and zinc chloride, being dealt with in great detail (60).

The acid celluloses, amyloid, hydrocellulose, ozonized cellulose and cellulose peroxide, together with oxycellulose are next developed from a practical standpoint (42), followed by the cellulose hydrates, alkali cellulose and mercerization (19). Cellulose condensations as with benzene and phenol, and the hemicelluloses are next considered, and the methods of producing amorphous cellulose for subsequent nitration (17).

The lignocelluloses, wood pulp, and their preparation for esterification form a section of 83 pages. The cellulose carbamates, animal celluloses, esparto, cellulose filters, plastics and aggregates including pergamin and cellulith, together with the bacterial action on cellulosic materials (24), brings the treatment of the subject to the last series of topics, where in 40 pages is delineated the qualitative and quantitative methods in use for the detection and estimation of the various materials previously described.

Starch

In the second chapter (Starch, 96), the origin, occurrence and transformation of starch is taken up (19), with starch iodide (5) and esters (3), and the action of enzymes, formaldehyde and heat of starch (8). This is followed by a discussion of the various soluble and modified starches of commerce (9) and their properties (12). Starch paste (4), and the manufacture

**Technology of Cellulose Esters*, by Edward C. Worden. Milburn, New Jersey, New York, D. Van Nostrand Co., London, E. & F. N. Spon, Ltd., 1921. In ten volumes. Volume I, in octavo, 4,000, or 4,182 pages, in five parts, bound in green cloth, 15 1/2 in. x 22 1/2 in., 296 illustrations; 151 tables; 344 collective indices of 623 pages containing 39,468 citations; 27,372 patents; 23,740 references to 23,332 names, and 20,370 entries to 20,601 different subjects. The 19,611 separately numbered footnotes contain 90,594 bibliographic references. Price \$40 (10 pounds, 10 shillings). Weight 19 pounds. Parts not sold separately.

of starch from potatoes, rice and corn (22), together with the action of diastatic ferments and acids (14) closes the chapter.

Cotton

Cotton (101) forms the subject matter of Chapter III. Topics such as the history, botany, microscopy, anatomical structure, fiber dimensions, moisture, nitrogen, mineral constituents and tensile strength of various cottons are first detailed (45), and the composition of cotton, tissue paper, cotton wax, and absorbent cotton described (11). The methods of cotton analysis, tests and inspection of cotton for nitration purposes, the requirements for nitrating cotton in various countries and its preparation for nitration forms the next group (27). The utilization of linters, hull fibers, fly, cop bottoms and other short fibers (14), together with their impurities, completes this section.

The preparation of cotton for nitration and acetation is described and illustrated in the next chapter (82), from the opening of the original bale to the purified cotton ready for immersion in the esterifying bath, including the boil-off, bleaching, drying, teasing, willowing, conveying and final drying, and containing separate sections for the specific practices as carried out in different countries.

Nitric Acid

Chapter V on Nitric Acid (343 pages) opens Part II and is divided into five sections, of which the first embraces nitrogen, its separation from the air, preparation and properties (28), the five nitrogen oxides being described individually (29). Then follows 123 pages on the various processes and their refinements which have been proposed for the manufacture of nitric acid from sodium nitrate; the origin, formation and extraction of Chili saltpeter, commercial utilization of niter cake, and the condensation, purification and utilization of nitric acid is described and illustrated.

Section two in 48 pages covers the broad subject of the fixation of atmospheric nitrogen by such methods as those of Schönherr, Birkeland & Eyde and Pauling, and the oxidation of ammonia to nitric acid by the Haber, Badische and Ostwald inventions (24). Nitrides, cyanides and cyanamides as sources of nitrogen (27); the recovery of nitric acid from various sources and its action on metals; the transportation storage and properties (14); and lastly, the various analytical methods for the determination of nitrous and nitric acids and their combinations, together with methods for the production of absolute nitric acid, its refinement, bleaching and concentration (44) complete the treatment. Undoubtedly this is the most comprehensive and modern treatment of the entire subject of nitric acid that has ever been printed.

Sulphuric Acid and Oleum

The occurrence, purification, production, properties and determination of sulphur and its two oxides form the opening section (115) of Chapter VI on Sulphuric Acid (396), followed by the manufacture of oleum as by the Badische, Tentelw, Schroeder-Grillo, Freiburg and Rabbe processes, including details of the multitude of contact masses which have been proposed and used for this purpose (77). The lead chamber in all its details follows (86), and the other processes for sulphuric acid production, including the recovery of waste acid from the several industries (21).

The properties of oleum and fuming acids, monohydrate, action of vitriol on various metals, detection and estimation of sulphuric acid and the impurities con-

tained therein, and the de-arsenication, decolorizing, concentrating, purifying and transportation, concludes the chapter (102). The Gaillard and Gilchrist inventions are treated *in extenso*. By a judicious allotment of a large portion of the information to the footnotes in small print, it has been possible to encompass within these four hundred pages a monograph of trustworthy information upon this most important subject.

Mixed Acids

But comparatively little authentic information has been published upon the practical side of mixed nitrating acids. Chapter VII in 115 pages, discusses the physics, chemistry, mathematics, preparation, fortification, recovery and denitration of mixed acids; the recovery of nitrous fumes; manufacture of mixed acids for the nitration of various grades of cotton for specific commercial purposes; the analysis of mixed and spent acids, and the calculation of acid baths.

There have been brought together in Chapter VIII (47) a series of 33 tables of the physical and mathematical data embraced in the foregoing sections on specific gravity, temperature corrections, thermal properties and sensible heat interchanges, and in 15 tables the correction factors for reducing nitric oxide at any temperature and pressure to standard conditions by inspection alone.

History and Theory of Cellulose Nitration

Having described the cellulose materials in Part I, and the acids that combine with them in Part II, with the formation of the various nitrocelluloses, this Part III (810 pages) covers, in Chapter IX (366) the historical development of the bewildering ramifications of the art from the original experiments of Braconnot in 1833 to the present time (115), the chemistry and nomenclature of nitrocellulose, and the theory of nitration.

The properties, such as stability, viscosity, hygroscopicity, and physical and electrical properties of the various classes of cellulose nitrates are discussed at some length (72), and including the ballistics, reduction of inflammability, and the physical properties of collodion membranes (34).

The nitration of straw, corn pith, jute, lignin, paper, starch, carbohydrates, saccharose, dextrin glucose, molasses, lactose, erythrite, mannite and resins are treated separately (80), and methods of manufacture given for each. The manufacture of pyroxylins of low nitrogen content and recovery, dyeing, indurating and denitrating of nitrocellulose are explained and illustrated (16), and methods given for the nitration of hydrocellulose and oxycellulose. The xyloidins, cellulose nitrites and sulphuric esters, and nitrated and chlorated guncotton (12) are adequately presented.

The final section has to do with the selection, layout and construction of a modern guncotton plant; dangers in connection with the nitration of cotton; and the rules and regulations which have been prescribed for the transportation of guncotton, pyroxilin and collodion, both in the dry and moist states (13).

Technology of Cellulose Nitration

Whereas the preceding chapter was devoted to the theoretical phases of nitrocellulose utility, Chapter X is concerned with the practical manufacture of the many and varied forms of this ester which find such wide application both in warlike and the peaceful arts (340). Nitration of cellulose by hand, direct dipping, pot, centrifugal and displacement, intermittent or continuous, both of cotton, paper and wood pulp, is cov-

ered in a logical and methodical manner (119).

The various treatments of the nitrated material from the drowning, pre-washing, through bleaching, boiling-off, pulping, settling, poaching, removal of foreign matter, blending, screening, centrifugal and hydraulic solvent dehydration, drying, compressing, granulating, colloidizing and co-nitrating are allotted 193 pages, the descriptive portion being supplemented by over 100 cuts, the majority being half-tones. The United States, British, French and German official specifications for loose and packed guncotton are given, and for nitro-cellulose in slabs for torpedoes and mines (15), and including the safeguards which have been thrown around the industry.

The analytical determinations of the foregoing materials are embraced in the 104 pages constituting Chapter XI, including the estimation of moisture, viscosity, solubility, unaltered cellulose, mineral constituents, acidity, alkalinity, sulphates, mercuric chloride, fineness, density, nitrogen, and the various fume, trace and stability tests.

Resumé of the Respective Arts

In the 710 pages covered by Part V, an attempt has been made to present adequately the historic development of the entire field of the cellulose esters, and we believe with a greater degree of success than heretofore has been made. The subject has been divided into 12 sections and 290 topics, and in order to compress the maximum of information into a volume of readable size, sources of information have been recorded in 12,483 separately numbered footnotes, some several pages in length.

The cellulose ester solvents, non-solvents, high boilers, plastifiers and ant-acids are first taken up historically (13), followed by selective information on acetone and the ketones (6), diacetone alcohol (2), methyl, ethyl, propyl, butyl and amyl alcohols (67), fusel oil (18), amyl acetate and other alkyl esters (24), and natural, artificial and synthetic camphor and camphor substitutes (40). The methods of solvent recovery and the handling of these inflammable liquids (11), follow proteid substitutes and ureas.

Paint and varnish removers and turpentine substitutes (10) form a separate section, as do the following: Cellulose nitrate, collodion and celluloid lacquers, varnishes, bronzing fluids and gold paints (14); the formation of imitation gold leaf and mother-of-pearl (4); pyroxlin-resin lacquers and incandescent gas mantels (10); and pyroxlin artificial leather and waterproofing compositions (15). Enameled paper and the printing on fabrics with nitrocellulose, together with collodion paper, leather and textile cements (6) cover the applications in these industries. Artificial filaments, nitrocellulose silks, and cuprammonium threads (34), indicate a field of rapidly expanding usefulness.

The pyroxlin plastics typified by celluloid and xylonite with the details of their manufacture form a chapter in chemical romance of absorbing interest. The manufacture, re-working, cutting, inlaying, dyeing, veneering and embossing of celluloid for collars, cuffs, studs, eyelets, golf balls and in phonography and photography, constitute a field to which 112 pages have been allotted.

The phenol-aldehyde substitutes for celluloid (12); the uses of celloidin and its development in microscopical technique (15), collodion sacs and the pharmaceutical collodions (11) form a prelude to the 121 pages devoted to the manifold uses of nitrocellulose in photography, especially in the production of continuous films for moving pictures.

The portion devoted to collodion in the photographic art includes precipitated pyroxilin, dry plates and collodion emulsions and their manufacture and ripening, together with preservatives, organifiers and sensitizers (52). Sensitizing leather and fabrics, collodion positives and collodio-chloride paper, print outs, gold toning and developing (12) comprise another section, followed by collodion carbon prints, transparencies, lantern slides and transfers (11).

Orthochromatic emulsions, light filters, color screens in photography, screen plates, color cinematography, subtractive and stripping films, halation and solarization, and the use of collodion in ceramics, photomechanical processes, X-ray screens and for solar and astronomical work (44) are indicative of the manifold applications of the nitrocelluloses in this connection, and including the uses in photoxylography and in spectroscopy. Celluloid dishes, measures, reliefs and focussing screens (9) terminate the subjects comprehended in this portion.

Guncotton, cellulose nitrate smokeless powders and pyroxilin in the arts of war form a series of topics of 66 pages, and is followed by the cellulose acetates and formates whose industrial recognition lies in their diminished inflammability (75). The cellulose xanthates, viscose and viscidol, the so-called "wood silk" (33), close the descriptive portion of the work.

Indices

The fifth and concluding part is taken up with the Indices, where, in 1,402 columns of fine print, are recorded over 93,500 separate Patent, Name and Subject citations. This is indicative of the scope and immense wealth of material contained in the work, the author being correct in his contention that "many an otherwise valuable book has been materially impaired by the omission, incompleteness, brevity or faulty construction of the index—in our judgment the most important and painstaking portion" of a work of this character.

The Author's Aim

The work in its sub-title is styled "a theoretical and practical treatise on the origin, history, chemistry, manufacture, technical application and analysis of the products of acylation and alkylation of normal and modified cellulose, and including nitrocellulose, celluloid, pyroxilin, collodion, celloidin, guncotton, acetylcellulose and viscose, as applied to technology, pharmacy, microscopy, medicine, photography and the warlike and peaceful arts," and the author has yielded to the temptation of building for this industry a foundation from the broadest viewpoint, for he believes that "every proposition of maximum utility must be self-contained."

"Be it monumental or otherwise—every effort of attempted merit has a definite aim. The aim of this work is to present the entire subject of the combinations of normal and modified cellulose with acid, and alkyl radicals in such completeness, clarity, accuracy and detail, that inability to locate the information desired in the Collective Indices, will be trustworthy evidence that the matter sought was either ephemeral, irrelevant, inaccurate, non-existent or valueless." A careful perusal of this stupendous work has impressed the reviewer that the above aim has been closely approached.

The text of this book has been reinforced by voluminous explanatory notes to the extent of over 19,500. Of the 3087 pages of text proper, less than 100 are free from notes, the major portion of these being devoted to reprints of, or excerpts from official docu-

ments. In many instances the explanatory, well-digested notes cover the entire page.

Conscientious Exactitude.

The details of apparatus, methods, processes and products drawn from these sources are set forth with completeness and minuteness, and a reader skilled in the art will perceive readily that the author—although describing methods of manufacture with unsparing frankness and with personal familiarity,—yet has observed that discretion which good taste, justice and chemical ethics demand. Some idea of the completeness with which the world has been combed for information is indicated by the fact that the Abbreviations to Literature alone occupy 84 pages of fine print, and include over 3,000 different sets of periodicals.

While scientific authorities have been widely consulted and their results presented with full credit, there is apparent throughout the entire work an exceedingly painstaking and successful effort to present the bewildering mass of material in a clear-cut, logical, sympathetic and readily understandable manner. This has been made possible first by division into chapters, next by sub-division into a large number of topics, and finally by handling each topic with the same continuity of thought and presentation of information. There are really two works,—the large print for the general reader, and the supplemental fine print in the notes for the expert.

A book of this technical character—as it should be for modern industries—is based upon the patent literature, of which over 27,000 patented processes and inventions have been described and referred to. The sections on cellulose, starch, cotton, nitric acid and sulfuric acid, it may safely be said, treat the subject more exhaustively from the purely technical point of view, than heretofore has been published in any language, and with a related account of the collateral and interdependent industries.

While this Volume I treats more specifically of the fundamental products comprising the industries to be described in the succeeding nine volumes of the series, yet in the 1500 pages allotted to the specific subject of nitrocellulose and its applications, supplemented as it is by nearly 300 illustrations, graphs, charts and flow sheets, the entire art from the earliest times to the present has been circumscribed with an accuracy and completeness heretofore unattained.

To Whom the Work Should Appeal

This volume should prove especially helpful to those interested in the following ten classes of industries:

- (1) Cellulose, paper, wood pulp, jute, and the treatment of all forms of cellulose as such for commercial purposes, including such products as vulcanized fiber, parchment paper, pergamin, cellulith and mercerization.
- (2) The manufacture of starches, either normal, modified or soluble, and the products derived therefrom.
- (3) The general subject of the growing, selection of cotton and its composition and the various treatments of bleaching, etc., which it undergoes to enhance its technical usefulness.
- (4) Any art which employs nitric acid or an inorganic nitrogen compound, including saltpeter, niter cake, cyanides, nitrides, cyanamides, nitrogen fixation and ammonia formation.
- (5) Sulphuric acid, sulphur in any inorganic form.
- (6) Properties, action and uses of mixed nitrating acids for any purpose.
- (7) That wide range of arts employing directly or indirectly any form or combination of nitrocellulose, cellulose acetate or other cellulose ester or ether, and including celluloid, xylonite, celloi-

din, collodion, pyroxylin and artificial silks of all kinds.

- (8) Viscose and viscose products, phenol-aldehyde, casein and other celluloid and plastic substitutes, lacquers, varnishes, bronzing liquids and water-proofing compositions, including the treatment and coating of textiles, leather and skins and the formation of artificial leather and leather substitutes.
- (9) Explosives, guncotton, dynamite, gelignites, smokeless powders and nitro propulives, photographic films, sheets and film base.
- (10) Solvents, diluents, camphor and its substitutes, paint and varnish removers and turpentine substitutes.

In short, this volume appears adequately to cover every phase of cellulose ester activity.

The original experiments of Braconnot must be regarded as the initiation of a new art in 1833; the researches of Schönbein paved the way for the translation of guncotton to the arts of war; the observations of Parkes, Spill and Hyatt formed the basis for the evolution of pyroxylin plastic technology; the attempts of Chardonnet to compete with the silk worm was the beginning of the artificial silk industry; so another epoch must be conceded as having been initiated by Worden for gathering together, recording, and rendering available in edited form, the dreams and realities of this important department of human activity by means of what chemists will understand when we fittingly call this colossal work, the "Cellulose Ester's Beilstein."

With the completion of the new paper-board mill of the Southerland Paper Co., Kalamazoo, Mich., that city will have eighteen paper mills and the distinction of being the foremost paper manufacturing city in America.

* * *

The Butterworth-Judson Corp., 61 Broadway, New York, has sold its plant at Lyndhurst, N. J., consisting of two acres with buildings of about 20,000 sq. ft. of floor space and formerly occupied by the Renslau Chemical Works, to the Goodwin-Reid Co., to be used for chemical and dyestuff production.

* * *

The N. K. Fairbanks Co., Chicago, Ill., for many years the soap manufacturing subsidiary of the American Cotton Oil Co., and since its establishment in 1867 a prominent factor in the industrial activity of Chicago, has transferred its head office to New York, at 50 Church Street, in pursuance of a plan for the centralization of administration.

* * *

The International Petroleum Co., the South American subsidiary of the Standard Oil Co. of New Jersey, has about completed a refinery in Colombia of a size ample to provide for that country's requirements of petroleum products made from native crude oil. The company's refinery in Para already provides for the needs of that country and exports its products to Chili, Panama and to Canada.

* * *

The Atlas Powder Company, Wilmington, Del., has underwritten the sale of the entire Class "A" preferred stock issue of Darco Corporation, Wilmington. This is the first issue of the corporation and amounts to \$1,500,000 in eight per cent. cumulative sinking fund shares, \$100 par value.

This issue will finance the construction of a 6,000-ton plant in Louisiana for the manufacture of Darco, the new refining carbon to be used in the manufacture of sugar, gelatines, edible oils, soft drink syrups and pharmaceutical products.

The Atlas Powder Company, by contract, has entire technical and manufacturing control and direction of Darco Corporation.

Personal Items

R. R. Lewis, formerly of the du Pont research staff at Experimental Station, Del., is chief chemist, J. C. Haartz, Inc., New Haven, Conn.

* * *

Herbert Philipp, chemical engineer, formerly at 50 Church St., New York, is now plant manager, Dicks-David Co., Chicago, Ills.

* * *

C. Propach, formerly representing the Grasselli Chemical Co., is now the Chicago representative of Geigy Co., Inc., at 113 West Austin Ave.

* * *

M. E. Kessler has resigned from the chemical staff of the Niagara Alkali Co., and is now with the Waste Products Co., Niagara Falls, N. Y.

* * *

Robert S. Scull, formerly technical director, Curd & Blakemore Co., Louisville, Ky., is now chemical engineer, Paul Delaney Co., Inc., Brocton, Mass.

* * *

Philip A. Patterson, formerly chief chemist, Lincoln Motor Car Co., Detroit, Mich., is now with the chemical department of the U. S. Rubber Co., at that city.

* * *

J. Benson Darlington, formerly chief chemist with the E. I. du Pont de Nemours & Company at Carney's Point, New Jersey, has resigned to go into other work.

* * *

Maxwell A. Cohen, formerly sales manager, Mass. Chemical Products Co., Boston, is now manager, The Keene Co., mfg. chemists, 355 Broadway, New York.

* * *

F. E. James, formerly manager of the chemical department of Marden, Orth & Hastings, has accepted a position with Innes, Speiden & Co., Inc., 46 Cliff St., New York.

* * *

Reeves W. Hart, formerly research chemist, Kullman, Salz & Co., San Francisco, Calif., is now of the research staff of the N. Y. Quebracho Extract Co., New York.

* * *

Herbert Greenwald, formerly superintendent of the Chicago plant of Marden, Orth & Hastings, Inc., is now plant superintendent of the Processed Oil Co., Carnegie, Pa.

* * *

E. E. Fischer, formerly president and treasurer, Kalle Color & Chemical Co., has been elected vice-president and director American Aniline Products, Inc., 80 5th Ave., New York.

* * *

Charles H. MacDowell, president of the Armour Fertilizer Works, has been elected president of the Western Society of Engineers, and brings to this position wide experience as an executive.

* * *

Harry W. Smith, formerly in charge of the Cleveland sales office of the Roessler & Hasslacher Chemical Co., Perth Amboy, N. J., has been transferred to the newly opened office of the company at Pittsburgh, Pa.

* * *

W. W. Kregel, formerly with the Nat'l Aniline & Chemical Co., Inc., is eastern sales agent of the Emery Candle Co., Cincinnati, Ohio, in charge of the newly opened offices of the company in the Woolworth Building, New York.

Aaron Friedman, formerly with Cooper & Cooper, Inc., 194 Worth St., New York, is now with the New Process Metals Corp., Newark, N. J. He will erect a plant for the manufacture of cerium and other rare earth metals.

* * *

B. H. Rawl, assistant chief of the Bureau of Animal Industry, U. S. Department of Agriculture, has resigned to take charge of the educational work of the California Central Creameries, with headquarters in San Francisco.

* * *

Perry H. Bascom, formerly chemical development engineer of the Dorr Co., is now with Philip E. Edelman, E. E., 39 Cortlandt St., New York, in charge of applications of the Edelman automatic chemical control and recording devices.

* * *

Wilfred W. Scott, Editor of Standard Methods of Chemical Analysis, has resigned as research chemist of the General Chemical Company and has accepted the position of associate professor of chemistry in the Colorado School of Mines.

* * *

C. L. Bryden, chief engineer Kelly Filter Press Co., New York City, and well known in the chemical industries as a filtration engineer, has associated himself with W. P. Heincken, engineer and manufacturer, 95 Liberty St., New York City.

* * *

James J. Hinde, Sandusky, Ohio, one of the founders of the Hinde & Dauch Paper Co., has organized the Hinde Paper Co., capitalized at \$1,000,000. The new company will establish a plant at Cleveland for the manufacture of fiberboard products.

* * *

Dr. G. R. Scholes, in 1914-1917 of the staff of Mellon Institute of Industrial Research, and later chemist for the H. C. Fay Glass Co., Rochester, N. Y., is now chemist in charge of glass-making and annealing processes for the Federal Glass Co., Columbus, Ohio.

* * *

Dr. John D. Rue, formerly professor of industrial chemistry, University of Michigan and later captain, Ordnance Department, and of the Mead Research Corp., succeeds Otto Kress as head of the pulp and paper dept., Forest Products Laboratory, Madison, Wis.

* * *

Wilson H. Low and John H. Shaw, formerly chief and assistant chief chemist, Cudahy Packing Co., Omaha, Neb., now of Los Angeles, Calif., have acquired the plant of the California Chemical Products Co. near Owens Lake, Calif., and will recover alkali salts from the lake water.

* * *

Hal T. Beans and Thomas B. Freas, who were associate professors at Columbia University, and Marie Reimer, associate professor at Barnard, have been given the rank of full professors. Samuel J. Kiehl, instructor in chemistry, and E. G. Miller, Jr., associate in biological chemistry, have been made asst. professors.

* * *

Recent changes in the administration and staff personnel of Arthur D. Little, Inc., Cambridge, Mass., embrace the appointment of Chester M. Clark, formerly director corporation department, Stone & Webster, Inc., as treasurer, and of Merton R. Sumner, formerly of the Fuller Industrial Eng. Corp., as chief engineer.

Industrial Notes

G. S. Alexander & Co., Inc., 61 Broadway, New York, have been appointed exclusive selling agents for the Union Sulphur Company in the states of North Carolina, South Carolina, Georgia, Florida and Alabama.

* * *

The plant of the A. E. Staley Mfg. Co., Decatur, Ill., manufacturers of starch, glucose, syrup, corn oil and gluten feed, comprises 29 buildings with over 725,000 sq. ft. of floor space on a 47-acre tract. The company ground $6\frac{1}{2}$ million bushels of corn in 1920.

* * *

The Ross Heater & Mfg. Co., Inc., Buffalo, N. Y., manufacturers of oil, sugar juice and chemical heaters, condensers, evaporators, etc., has opened a branch office for the New York district at 2 Rector Street, in charge of C. M. Hardin, formerly of the home office.

* * *

The Hercules Color Corporation is a New Jersey corporation, with New York offices at 2 Rector street, with J. F. Reichard president and A. H. Mathieu vice-president. It has the exclusive sales agency in New York and New Jersey for the basic colors of the Dicks-David Co.

* * *

The National Brewing Co., New Orleans, La., which since the enactment of the 18th Amendment is the National Industrial Alcohol Co., Inc., will install additional equipment for the increased manufacture of industrial alcohol in connection with the production of cereal beverages.

* * *

Richard K. Meade & Co., 11 E. Fayette St., Baltimore, Md., has designed and in process of construction a 50-ton daily capacity hydrated lime plant for the O. J. Keller Lime Co. at Frederick, Md. A plant of the same capacity also is being built for the Fountain Rock Lime Co. at the same place.

* * *

The Ault & Wiborg Co., Cincinnati, Ohio, is moving its varnish works to the plant of the Queen City Varnish Co., acquired several months ago. The Cincinnati Chemical Works has purchased the vacated property, which it will remodel and conduct as a branch of its main plant at St. Bernard.

* * *

The Fer-Sul Chemical Co., Fredericksburg, Va., capital \$1,250,000, will build a 60-75 ton sulphuric acid plant at Atquit, Va., to operate pyrites obtained from local mines. Paul H. Brattan is president and E. W. Black secretary. Plans and construction are by the National Laboratories, 1313 H St., N. W., Washington, D. C.

* * *

Canadian Salt Co., Ltd., with plants at Windsor and Sandwich, Ontario, for the production of caustic soda and bleaching powder from salt by the ammonia-soda process, is not only the largest Canadian producer of salt but the only producer of its products in Canada. During the past four years its output has been 55 per cent. of the volume of these products consumed in Canada.

* * *

The transfer of interest in nitrogen fixation from war to agriculture is given as the reason for Secretary of War Weeks' approval of the continuance of the fixed nitrogen laboratory maintained by the War De-

partment at American University, Washington, D. C., at an annual outlay of \$250,000 and employing over 100 chemists, until such time as is deemed best to transfer the work to the Department of Agriculture.

* * *

The Koppers Co., Pittsburgh, Pa., has been awarded the contract to build the coal gas plant for the Public Service Gas Co., Camden, N. J., consisting of 37 triangular-flued combination gas ovens, with a capacity of nine net tons of coal per charge, and four Koppers-Kerpely producers. The ovens will be heated with producer gas, thus releasing the coke oven gas for sale, and the producers, in turn, will be operated with coke made at the plant.

* * *

John F. Welch, president Welch Grape Juice Co., with plants at Westfield, N. Y., North East, Pa., Lawton, Mich., and St. Catharines, Ont., with an annual production capacity of 2,000,000 gallons, in a plea before the Senate Finance Committee for tax reduction on unfermented grape juice, said that untaxed homebrew and cereal beverages have reduced the 20 million gallons annual capacity of 20 American grape juice producers to 7 millions.

* * *

The Secretary of the Treasury announces that the War Trade Board section of the Department of State has ceased to exist and all clerks and employees of the former War Trade Board section have become clerks and employees of the Treasury Department. For the purpose of administering the emergency tariff act in relation to the control of importations of dyes and chemicals, a section to be known as the Dye and Chemical section of the Division of Customs, Treasury Department, has been organized.

* * *

The E. I. du Pont de Nemours & Co.'s investment in General Motors Corp., which is held by the subsidiary Du Pont American Industries, Inc., approximates 7,000,000 shares of common stock out of a total of about 20,445,000 shares outstanding.

Plan of keeping ownership of General Motors stock in a subsidiary is for the purpose of disassociating this investment from the company's manufacturing business, in order that there may be an independent development of each. This segregation may be rendered more complete at some future date by permitting shareholders of E. I. du Pont de Nemours & Co. to acquire common stock of Du Pont American Industries, Inc., upon favorable terms or through dividend distribution.

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CHEMICAL AGE

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A Plea for Rational Judgment in Dyestuffs Legislation

By George H. Whaley

President, John Campbell & Co.

REGRETTABLE is the tendency to becloud a strictly economic problem which has an intimately vital relation to national welfare with the partisanship of politics.

The American people have been apprised by that most effective teacher, the returned doughboy, of the essential part that chemistry played in winning the war. The educational functions of the press have been active in telling the story of how American ingenuity and enterprise, under the compulsion of the deprivation of dyestuffs and pharmaceuticals, previously the products of German-encouraged monopoly, laid the foundations of an American dyestuffs industry.

Leaders of opinion not only in America but throughout the manufacturing nations of the world have taught that although it is impracticable and unwise to disarm Germany in what has become the most essential arm of warfare by the destruction of her dye plants, it is emphatically the part of wisdom to destroy her monopoly of experience and facilities in the manufacture of commodities which in actual volume and value are almost negligible in the sum total of national enterprise, but which are determinative of national welfare and perpetuity.

Great Britain, France, Italy and Japan already have taken effective measures to encourage national enterprise to make their respective peoples independent and self-sufficient in the products of applied chemistry in the field of dyestuffs and pharmaceuticals, experience in the manufacture of which immediately is available for the production of explosives in the event of war. It was the general lack of this experience among the Allies that permitted Germany, who possessed it, the headway in the war, and which prolonged it until the

Allies, at a sacrifice from which we suffer today, supplied the deficiency.

We all realize the creditor position that America occupies, with an increased production capacity that requires for its approximately complete operation a foreign trade that aggregates 10-20 per cent. of our total volume of business. We know that for the advantage of the world the stupendous indebtedness of our Allies to us can be paid only as they can produce goods; that we can prosper only as the world prospers and particularly that portion where the per capita purchasing power is the highest and that is among our Allies in the war. Each is doing exactly what we wish to do in America, viz: to make our chemical industries born of the perplexities and demands of war safe from the destructive commercial tactics of the element that instigated the war until such time as with acquired experience and improved facilities we can meet them in fair competition all along the line of the innumerable products of coal-tar chemistry.

We do not wish to deprive the American consumer of dyes in the many industries in which they are essential of any product

which at the present time is not American-made in quantity, quality and price attractiveness equal to that made in Germany.

The American market by logic and nature belongs primarily to the American workmen and American manufacturers. By no reasoning can it be established that the industry of American coal-tar derivatives seeks to alienate from them any advantage in the markets of the world. On the contrary it seeks to confirm to them, insofar as in its enterprise lays, the American standard of living and the fullest trade op-



GEORGE H. WHALEY,
President, John Campbell & Co.

portunities in its desire to add to American self-sufficiency and industrial equilibrium.

There is a tendency on the part of some of our national legislators to believe that there is a monopoly being organized to control the dyestuff business in America. This is an impossibility due to the fact that there are several thousand separate and distinct products to be derived from coal-tar which are classified as dyestuffs and coal-tar drugs.

There are over two hundred individual manufacturers, without affiliation with any other corporation, who are using their own capital without resort to public funds. It is a free field and competition simply narrows down to a question of which organization can compound and manufacture the most desirable dyestuffs and coal-tar drugs of the best quality at the lowest price.

The United States Tariff Commission has made a study of the dyes produced during 1920 from the standpoint of the number of manufacturers producing each dye and shows that of the 360 dyes produced, 108 were each manufactured by three or more firms; the output of these represented 92 per cent of the total quantity produced in 1920. Of the total number of dyes produced, 200 were each manufactured by one firm only, but these dyes represented only 5 per cent. of the total output. A fact of still greater significance was that over one-half of the total output consisted of dyes (35 in number) each of which was made by seven or more separate firms. The total number of firms engaged in the production of coal-tar products in 1920 was 213, while those companies engaged in the manufacture of dyes alone numbered 82.

The progress made during the past four years has been creditable, and we are far ahead of any other country except Germany and Switzerland, who have organizations of long standing, where they are benefited and helped by every educational institution as well as their governments. Already the American universities, technical schools, and trade schools are intensely interested in the subject of organic chemistry particularly with reference to dyestuffs and coal-tar drugs, and it will probably be at least five years, to the best of our ability to foresee, before America will have enhanced her position to such an extent that she will be independent of any other country.

Of the 213 firms, 76 have separately organized research laboratories engaged in the solution of production problems and in the development of new processes and products. The total research work done in the industry in 1920 involved the expenditure of \$3,806,798, which covers salaries, apparatus and materials, less the value of salable products, and is considered an understatement of the capital invested in the year's work of extension of our knowledge in coal tar chemical manufacture. The reported cost of research in this single department of chemical manufacture for four years, 1917-1920, is \$15,126,739. Extended research is necessary to establish the dye industry on a solid competitive basis.

The elaborate preparation necessary to this end cannot be accomplished in a short time, and if the impetus to research is destroyed by allowing foreign materials to come in here at ruinous prices, not only will capital be timid, but the incentive to develop will be destroyed.

At present the returns to the manufacturer are nil for the reason that all profit derived from the sale of the produce is put back into new plants and operations. This procedure will have to continue until manufacturing schedules can be maintained, and this is controlled almost entirely by the encouragement which we expect

to get from our government in the way of protection from foreign competition.

My organization has been in this business for forty-four years, part of the time as importers and part of the time as manufacturers. Our plant at Newark, New Jersey, was erected in the year 1915. We feel, therefore, that we are in a particularly good position to know what will and will not protect this industry. In our opinion the levying of a specific and ad valorem duty, even if the latter is based on American values, will not alone suffice to protect the American dyestuff manufacturer at this stage of his development.

The dyestuff manufacturers in general have appealed for an embargo, under certain conditions, on such dyes as are being successfully manufactured in the United States, with certain provisions for the licensing of imports of dyes which are not made in this country. Obviously the latter provision is in the interest of the various dye-consuming industries. It is, however, a just and reasonable provision and there is, in our opinion, no good and valid reason why the United States, Great Britain and France should not, with advantage to our nation, act in complete harmony and all adopt the same general principles as applied to this key industry.

We are not disposed to doubt or question the intent of this Congress to protect adequately this industry, but the facts from our side are that if this is not done according to the real needs of the industry, every American plant will have to close, with all that it signifies in the economic waste of unproductive capital and increased unemployment. Can Congress afford deliberately to throw labor out of employment in America today?

Our industry is a highly technical one and sensitive to criticism. The staffs of men employed in this industry are on edge. They all work seven days a week and are at our command twenty-four hours out of each day. After four or five years of the most intense effort we find the personnel of the American dyestuff manufacturers to be, as a body, completely discouraged by the non-action of Congress.

Why should politics have anything to do with the building up and protecting of one of the country's most important and essential industries? The old feuds dating years back, which bear no relation to this subject matter, should not be taken into consideration.

This is the key industry. We talk about fostering infant industries! Is it not a fact that we must do more than this for the key industry? Why will you not help us to build rather than to destroy?

Your own son who perhaps may be attending college is interested in the study of organic chemistry. It reflects itself all through our educational system. The ramifications and complexities of the subjects are beyond the comprehension of a non-technical man. Only one of high technical education understands the danger which confronts us by the present attitude of the United States Senate, simply because a certain few Senators fear a monopoly, which has absolutely nothing to do with and has no bearing on the fostering of the industry.

My organization has three millions of dollars invested; all its own capital. We haven't borrowed any money and there has been no stock flotation. It would be an easy matter for us to throw our influence in behalf of letting down the tariff bars and importing foreign colors. It would cause us far less expenditure in the future and would enable us to cut down our expensive organization, but we are in the game to show that America can do more in commercial synthetic chemistry than any other country.

Futility of Compulsory Operation of Patents

Disapproval of the Stanley Patent Bill, S.1838—The Same Being a Personal Letter to the Hon. Reed Smoot,

By Edwin J. Prindle

Chairman, Patent and Related Legislation Committee, American Chemical Society

I AM very much opposed to the Stanley Patent Bill, S. 1838, believing it to involve immensely more harm than good when considered in all its reactions. I believe that, considering the workings of the Patent System as a whole, it should not become a law.

I have no German clients nor German sympathies. My son volunteered in the Marines and was killed in action in the Great War at Blanc Mont Ridge in October, 1918, while my step-son volunteered in the Navy and spent fifteen months fighting submarines off the coast of France.

I earnestly request the consideration of the following reasons which, in my opinion, show that the bill should not become a law:

This bill is stated by its introducer to have been introduced at the request of the Secretary of War because foreigners were patenting inventions relating to ordnance which had been made by American engineers and selling them to the Krupps and the Krupps were buying them so that we could not use our own inventions for our own defense. The bill provides that any patents issued to persons who are not citizens of the United States shall be worked in this country within two years from the date of issue under penalty of having licenses granted under them by our government to others than the one who wished to work them.

A Dangerous Innovation—The Proper Remedy

The bill introduces a dangerous innovation into our law and has the possibility of far-reaching consequences not intended by those who drafted it and therefore requires the most serious consideration. It may be remarked at the outset that the remedy for preventing the Germans from patenting the inventions made by Americans, but which have not been patented by the Americans, is simply to prove when a suit is brought under the patent that the invention was made and publicly used by Americans before the application by the Germans for the patent was filed, which proof would result in invalidating the patent.

If the object of the bill is to compel the Germans to manufacture the invention in this country that would be just the opposite of the efforts which were made during the war to root out the "peaceful penetration" of American industry by the Germans.

For instance, the newly created American dye industry is not only necessary because of the dyes which it is producing and will produce, but it is vital to the defense of our country, because the chemistry of dyes is intimately related to and plants for manufacturing them are easily adapted to the manufacture of explosives, poison gases and the antidotes therefor, and all the principal chemical products which played so tremendous a part in the Great War.

After a war has begun men cannot be trained in such chemical production in time for a sudden emergency, and they must not only be qualified to manufacture the known explosives, poison gases and the antidotes therefor, but also to devise new ones to meet or overcome those which the enemy may produce during the war.

It is so necessary to protect this new industry that Congress has extended an embargo against the importation of German dyes. In so far therefore as the

Stanley bill would tend to force German owners of American patents to manufacture in this country, it would be contrary to the present efforts of Congress and the dye industry to prevent that very thing.

Moreover, where an invention is one which could be kept secret, as in the case of many chemical inventions, the Germans either would not patent the invention in the United States, keeping it secret in Germany, so that Americans would get no knowledge of it at all and would not be able to use it after the expiration of the patent, as is now the case, or the Germans would work the invention in this country in order to maintain the complete monopoly of the patent and prevent the granting of inventions. Either of these alternatives would seem to be less desirable than the present state of affairs, for in one case our public would get no use of the invention, and in the other case would get no knowledge of it, so that in either event the bill would fail to do any good.

Logical Extension to American Patents

Furthermore, there is grave danger that if compulsory working, under penalty of having licenses granted to others, is introduced into our law, as applied to patents issued to foreigners, it will be extended to apply to all American patents. In fact, members of Congress have already expressed the opinion that such should be the case.

Objections Stated

I consider that it would be a catastrophe to require that all American patents be worked within any limited period under penalty of losing the monopoly by having licenses granted thereunder by the government for the following reasons, among others:

Such a provision would strongly tend to impair the value of patents and would, to that end, discourage or fail to induce the production of inventions, which is the prime object of the American Patent System. Comparatively few inventions would be produced if it were not for our Patent System, and such inventions as were produced would be largely those which could be monopolized by being kept secret.

Americans are not naturally more inventive than the people of Europe, for we are all descendants of Europeans; so that the great prevalence of the inventive faculty in America is due to the stimulus of the promise of a monopoly for seventeen years which our patent law offers as an opportunity to the inventor to make money out of his invention, if it has sufficient commercial merit and he has the ability to make money out of it by supplying it to the public. It almost invariably costs money and time, and usually a great deal of both, to produce an invention of any value, and few men could afford, or would have the inclination, to make an invention if it were not for the opportunity to get a return from it through the monopoly which a patent will afford.

Our Patent System has been so successful in inducing the cultivation of the inventive faculty and the production of inventions that, more than any other factor, it has raised us to the foremost position as a manufacturing and agricultural country. If the individual inventor, or even the corporation, were faced

not only with the often back-breaking burden of expense in developing an invention, but also with the necessity of putting that invention on the market within two years—or even a much longer period of time—under the penalty of having the value of the monopoly weakened or destroyed by the granting of licenses to others, they often would not attempt what is now successfully put through.

The Economics of Patent Operation

An invention often is of no commercial value because it is ahead of its time. Other means or conditions with which it has to work have not yet reached a state where it is convenient or profitable to use the new invention, and the patent must wait until the art has grown up to it before it can be worked profitably.

Under these circumstances the expense of working it commercially would be thrown away entirely. An apparently trivial invention may have no value until toward the close of its life, when the idea which it protects may be the key to the then most commercial form of the article to which it relates, and the patent may have great value for the last few years of its life.

A successful manufacturing concern usually will only buy a patent when it can get the complete monopoly and the monopoly of his idea having been destroyed the inventor would be embittered by the loss which he unnecessarily would sustain, and he and all other inventors who knew of it would be partly or wholly discouraged from making further inventions.

The making of a successful invention today is not usually a question of a single patent, but in the course of the development of the invention, to a thoroughly commercial form, a group of patents has usually been taken out, either upon the article itself or upon instrumentalities and processes for its manufacture, and the patents of others are often found to be infringed and need to be purchased. In such a case the patents would usually have been taken out successively over a number of years, and thus each patent of the series, under the Stanley Bill, would have to be worked within two years while the working of that patent alone was of no commercial value and the success of the enterprise, as a whole, was still in doubt and might never be achieved.

It usually is an expensive operation to prepare for and work a patent, and the burden thus imposed would be one which even the largest corporations frequently would hesitate to assume.

The requirements of the Stanley Bill obviously would discriminate strongly in favor of the wealthy and against the poor inventor. That would not only discourage the production of inventions but harm industry in general, for there are many successful businesses in this country which are based upon the inventions of their owners made when they were without capital.

No country which has a compulsory working clause in its patent law produces anywhere near the number of inventions per capita or in importance as are produced in this country. The very small and seemingly insignificant inventions produced under our patent system are often of great value to the public, although usually not to their inventors, because they lead step-by-step to a point of view from which some one sees an opportunity to make a really important invention that would not otherwise have been produced.

Importance of Our Patent System to Industry Demands Caution in Any Proposed Innovation

Our Patent System has been of such enormous value and of so much greater advantage to our country than the patent system of any other country that changes

in its fundamental principles should be made only with the greatest caution, and then after moral certainty has been arrived at that the net result of all the reactions of any change will be beneficial rather than harmful.

I believe that the changes proposed in the Stanley Bill would be much more harmful than beneficial and would probably ultimately be disastrous, and I therefore urge that the Stanley Bill be opposed vigorously.

American Artificial Silk Industry

The announcement of initial operations of the Du Pont Fibresilk Co.'s recently built plant on the Niagara River, between Buffalo and Tonawanda, N. Y., directs attention to recent expansion in America of the artificial silk industry. Originally established successfully by the projection of Courtauld's, Ltd., of Coventry, England, in the reorganization of the American Viscose Co. as the Viscose Co., with plants at Marcus Hook, Pa., and later at Roanoke, Va., the success of the pioneer enterprise has been followed by the projection of Belgian interests, the Tubiza Artificial Silk Co., in the construction of an American plant at Hopewell, Va.

The Du Pont Fibresilk Co. is the projection of French interests represented by the cooperation of the Comptois des Textiles Artificiels of Paris, France, with E. I. du Pont de Nemours & Co.

Additions to the production facilities of the Viscose Co. at Roanoke comprise doubling its present annual capacity of 5,000,000 lbs.; and of the American Cellulose & Mfg. Co., Amcelle, Md., expansion to embrace the making of filament. A new corporation, the Cellulose Silk Co. of America, has acquired the Patterson Mills at Chester, Pa., and will utilize cotton waste by an improved supra-ammonium process. The American Fibre Products, Inc., has established a plant at Hawthorne, N. J.

National Exposition of Chemical Industries

The Seventh National Exposition of the Chemical Industries, which will be held during the week of September 12, at the Eighth Coast Artillery Armory, Jerome avenue and Kingsbridge road, Bronx, New York City, promises to be in line with previous exhibitions in each surpassing its predecessor in number of exhibits and attendance. Ancillary educational attraction is provided during the preceding week by the joint fall meeting of the American Chemical Society and the Society of Chemical Industry, the members of which organizations thus being enabled to combine the scientific and commercial interests of their work.

Educational activities during the week embrace symposia on (1) evaporation and drying, (2) crushing, grinding and pulverizing, and (3) material handling methods and equipment, together with motion pictures covering numerous aspects of chemical industry.

Previous expositions at the Grand Central Palace have made necessary the display of exhibits on several floors. The present exposition in the Armory permits on its floor space of about 300x600 feet unobstructed by pillars, and the largest structure of its kind in the world, the entire number of exhibits of 400 and more, together with ample, convenient and comfortable area for assemblage in an auditorium seating 1,400 people.

These advantages both to exhibitor and visitor, together with the accessibility of the location, which is distant only 30 minutes by subway from the Grand Central Station, should serve to make the attendance notable in volume and value to the exhibitor.

Recovery of Waste Nitrating Acids

Sources, Denitration, Fortification and Utilization of Spent Acids from the Nitration of Cellulose, Starch and Aromatic Compounds and the Concentration, Clarification and Purification of the Nitric and Sulphuric Acids Contained Therein.

By Dr. Carl Marx

THE economical recovery and utilization on a commercial scale of the immense amounts of spent acids necessarily produced as a by-product in the manufacture of organic compounds, especially the nitro-bodies, is a problem of increasing importance. The prodigious tonnage of explosives produced in the United States and elsewhere during the recent conflict naturally has led to increased interest in the problems of denitration and recovery of nitrating acids which have once fulfilled their function.

Herein is detailed the subject of spent acid recovery and utilization from the practical viewpoint, endeavoring to present only the more widely applicable and used processes; dealing first with the sources of spent acids, their denitration, fortification and utilization, and concluding with a short resume of the present methods of concentration of sulphuric acid, and a description of the Gaillard tower system and the Kessler concentration apparatus.

Sources of Spent Acids

In normal times there are but two main sources of spent acids; those from the nitration of aromatic hydrocarbons or their alcohols as benzol, toluol or phenol; and those resulting from the esterification of glycerol, and the carbo-hydrates cellulose and starch. While the spent acids from the former consist of sulphuric acid with but minimal amounts of nitric acid and relatively large amounts of water, those from the latter source contain many times more nitric acid, and therefore are more frequently submitted to the denitration process.

Separation of Waste Acids

The spent acids from the liquid nitro-compounds may be separated advantageously from the lighter nitrated bodies by gravity, preferably at an elevated temperature with comparatively low melting bodies such as the dinitrobenzenes. The spent acids arising from the nitration of cellulose and starch are either separated centrifugally as in the du Pont method of nitration, by displacement as in the Thomson process or by some method of filtration, the last being especially valuable in the separation of picric acid and the nitrated toluols.

Clarification

The unavoidable carrying over of suspended matter in the nitrating acids renders clarification often necessary, especially in those methods employing continuous rejuvenation, and is a comparatively simple procedure. Either gravity filtration through a porous mass unacted upon by mineral acids, or settling, will remove sufficiently the insoluble material to admit of profitable further treatment.

As early as 1882 the value of acid fortification was realized, in which year F. Pool obtained protection for a process for removing flocculent matter in suspension and involving the addition of finely divided heavy spar with agitation, the insoluble barium sulphate mechanically entangling the fibers and carrying them to the bottom by subsidence. With a tank four feet deep, containing 680 gallons of mixed acids, 30 pounds of barium sulphate were found sufficient when allowing 36-70 hours for settling.

E. Allary five years later proposed to clarify waste

acid from nitrocellulose by filtration through finely powdered quartz; while J. Porter has lately claimed a material made by fusing together quartz sand and powdered glass at a temperature of 1140-1700°, as being suitable for filtering strong acids. "Filtros," a siliceous material made by the General Filtration Co., has also proven valuable for the removal of suspended matter in strong acids. Filter cloth or paper made of nitrated cellulose has been effectively employed for the filtration of acids, having been originally proposed by R. Boettger in 1860, the first patent being that of O. Hering for the Farbenfabriken vorm. F. Bayer & Co. This was made by the nitration of filter cloth, the weaving of cloth from nitrated fibers or artificial filaments having been found to be impractical.

Denitration

By far the most important step in the recovery of spent acids is that known as denitration, and much thought and time have been devoted to this problem. For the purposes of this article the theory of denitration will be taken up first, followed by a description of the more important denitration processes such as British munitions practice, the Evers, Guttmann, Jahn, Patterson and Vender systems. Following this the absorption of nitrous fumes and the fortification of mixed acids without previous denitration will be detailed.

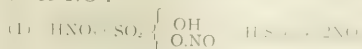
Theory of Denitration

Sulphuric acid is now generally believed to form a definite compound with nitrous acid, known as nitrosyl-sulphuric acid, and inasmuch as this compound is quite stable in the presence of concentrated sulphuric acid, the separation of nitrous, nitric and sulphuric acids is not as simple as at first thought might appear.

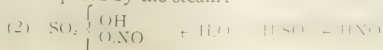
In order to effect complete separation of nitrous and nitric acid from mixtures with sulphuric acid it is necessary first to dilute the mixture until the concentration of the sulphuric acid is less than 70 per cent., and then to heat the same to a sufficiently high temperature to drive off the volatile constituents and gases. The resulting vapors of nitric acid are condensed while the nitrous gases, consisting essentially of NO and NO₂, are absorbed in 55% nitric acid, the final oxidation of the absorbed gases being effected by admixture and agitation with atmospheric oxygen.

These operations are carried out best in denitration towers of acid-proof material, the spent acid being allowed to trickle down through the packing of the tower while being subjected to an ascending current of super-heated steam and air, the steam serving both to dilute the mixture and to drive off the nitric acid. The reactions which take place may be summarized as follows:

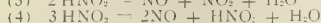
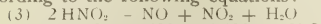
Near the top of the tower the nitrosyl-sulphuric acid decomposes any nitric acid present with the formation of NO₂:



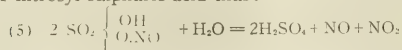
Further down the remaining nitrosyl-sulphuric acid is decomposed by the steam:



The nitrous acid thus formed being decomposed at the elevated temperature here prevailing, probably according to the following equations:



the nitric acid distilling off. It also is impossible that one molecule of water may react with two molecules of nitrosyl-sulphuric acid thus:

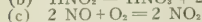
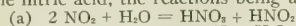


or

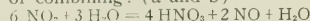


The denitrated sulphuric acid, containing about 67-70 per cent. of H_2SO_4 , which flows off from the bottom of the tower, will retain not over 0.15 per cent. of nitric acid and is suitable for concentration and re-use.

The nitric acid in the gases leaving the tower is first led through a set of Hart condensers where any nitric acid is liquefied and recovered, the non-condensable gases, consisting of NO and NO_2 , passing on to an absorbing apparatus where they encounter a downward current of nitric acid, experience having shown that 55 per cent. nitric acid possesses the maximum absorptive capacity. The air which is also present serves to oxidize the absorbed NO_2 to HNO_3 , thus enriching the nitric acid, the reactions being as follows:



or combining: (a and b)



The nitric acid obtained is suitable for use in mixed acids or as such, averaging between 53-58 per cent. in strength.

The conditions for most favorable absorption, neglecting for the moment the oxidation of the NO and NO_2 , depend mainly on the following factors:—the concentration of the nitrogen peroxide in the gases; the space velocity (volume of gases passing through the system per hour divided by the free space); area of wetted surface; concentration of the circulating nitric acid; and the temperature. Although oxygen is essential it has been found that an excess of air is to be avoided, the rate of oxidation being directly proportional to the concentration of the nitrous gases. Careful experiments have demonstrated that the optimum absorption and oxidation are attained by a load on the absorption towers of 1 pound of NO_2 per minute per 75-100 cu. ft. of free space. The most suitable temperature at which to operate is 40°C , although this may not be controllable in summer, temperatures as high as 70°C often being met with.

English Munitions Practice

The Department of Explosives Supply of the British Ministry of Munitions has carried out extensive researches on the problems of denitration and worked out practical methods which were adopted and put into operation on a huge scale, the results of these experiments being laid down in a recently published book entitled "Technical Records of Explosives Supply, 1915-1918. No. 1." Some data incorporated in this article has been drawn from this source, to which acknowledgment is made.

The process finally adopted is a modification of the Evers system (described below), the cycle of operations being outlined under Theory of Denitration as just described. It was found that by preheating the spent acid to 60°C great economies were obtained and the output of the units considerably increased. The denitrating towers were constructed of $\frac{3}{8}$ -in. steel,

3 ft. 2 in. diameter and 20 ft. high, lined with stoneware set in acid-proof cement, the towers being packed with graded quartz from 4-in. mesh to $\frac{1}{2}$ -in. mesh. Steam was blown into this tower through special nozzles at a temperature of 210°C , air being admitted by means of air lifts which also served to elevate the acid. Hart condensers were used to liquefy the nitric acid, the absorption towers for the nitrous gases being constructed of stoneware. The efficiency of this plant often ran as high as 90 per cent.

Evers Denitration Process

This process is the invention of R. Evers (1904) and covers both method and apparatus for the recovery of nitric and sulphuric acids. The plant is illustrated in Figures 1 and 2 and consists of a denitrating tower, a cooling arrangement, a condensing tower and a firing place. The essential features of the process are to insure most intimate admixture during absorption, this being specifically brought about by reducing the acid to a very fine state of subdivision, by interposing obstacles in the path of the entering gases and heating the waste acid to be recuperated. A temperature of from 160 - 170°C is maintained in the denitration towers by introducing superheated steam and air at several different points. Owing to the employment of heated air, the organic impurities are oxidized almost completely so that the recovered sulphuric acid is practically water-white and suitable for re-use, the nitric acid being recovered in almost colorless condition and of from 34-36° Be. in strength, or where the strength is brought up above 40°Be . the nitric acid is colored yellow.

The spent acid is passed down the tower "a" Fig. 2, into which air and steam from the furnace "g" are introduced through the tubes "s." The sulphuric acid collects at the bottom and the nitrous gases pass through the condenser "b," and then up the absorbing column "c," down which water or other cooling or condensing liquid passes. The columns "a" and "c" are divided by horizontal partitions "h" having central apertures into several compartments. In these compartments are placed a number of mixing devices "i" and a number of tubes "k," some of the latter also being placed in the condenser "b." Each mixing device consists of a central perforated cone "l," receiving mixed air and steam from the tubes "m," and surrounded by an outer perforated cone "p" having ribs or plates "q, q'" which are shaped so that the liquid flowing down from the cup "q'" spreads over the whole surface. The liquid finally escapes from the arms "r," which are curved at their outer extremities so as to cause the outer cone to revolve. The tube devices "k" consist of a double set of vertical tubes "t, t'" having their lower mouths open and turned alternately inwards and outwards.

The most striking feature of the Evers process is the strong preheating of the admitted air and steam, the temperature being preferably not lower than 400°C . Furthermore the denitrating tower is not made of uniform diameter, but gradually and uniformly widens toward the top so that the velocity of the gases and the pressure is maintained regularly and with a predetermined uniformity. J. Rudeloff has published a detailed description of the installation and working of an Evers plant in the *Zeitschrift für das gesamte Schiess- und Sprengstoffwesen* 1907, Vol. 2, p. 144. It is stated that one installation in a twelve-hour day will handle 8,000-10,000 kilograms of waste acid of the usual composition (say 70 per cent. sulphuric acid, 10 per cent. nitric acid and the balance water), the sulphuric acid being eventually recovered colorless and without loss while the loss of the nitric acid is said to be only about 0.1 per cent. The coal consumption is 3 per cent. based

on the weight of the acid treated, the repairs and upkeep being small.

Vender Denitration System

This invention is based on the discovery that the hot gases generated by the combustion of the nitrogen in the atmosphere by means of an electric arc, by direct contact is capable of denitrating nitrous sulphuric acid in a much more efficient manner than is accomplished by means of heated air, sulphuric acid of 98 per cent. strength being easily obtained.

The process is carried out commercially by means of a system of two towers arranged relative to each other in such a manner that the hot gases produced by the combustion of the nitrogen heat the first tower on the outside, thence passing to the interior of the second tower. This tower (the denitrating unit) is fed with spent acid while the hot gases pass upwards, the denitrated sulphuric acid being withdrawn at the bottom and the nitric acid and nitrous gases recovered as in the Evers and British system.

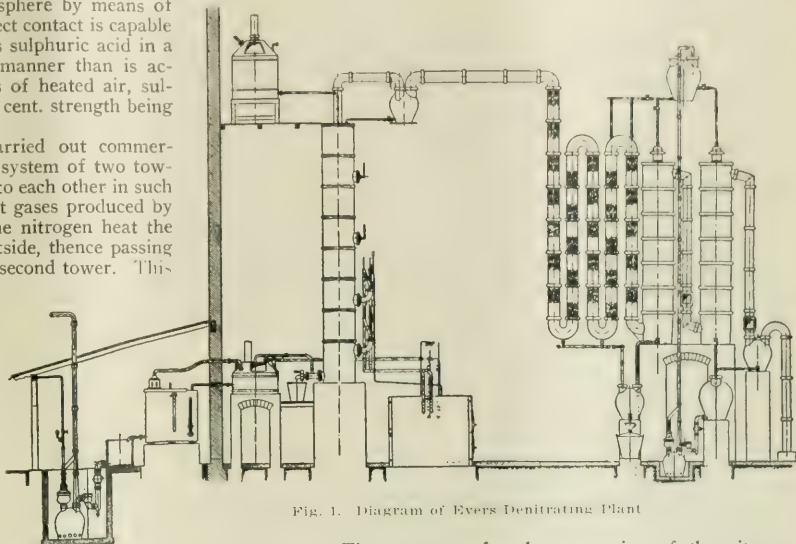


Fig. 1. Diagram of Evers Denitrating Plant

Guttman System

Oscar Guttman in 1896 evolved a denitrating system which comprised the use of a special tower packing, termed by the inventor "denitrating stones," consisting

of hollow earthenware balls, perforated in four places, the theory held being that the interior of the "stones" would retain a certain amount of liquids in the cup-like depressions thus tending to increase the effectiveness of the system. (See Fig. 3).

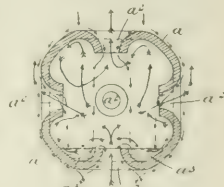


Fig. 3. Guttman Denitrating Stones

Nitric Acid Recovery by Solvents

The Dynamit Aktien Gesellschaft has disclosed a process for the regeneration of the nitrogen oxides by solution in esters of the paraffin alcohols, the ethyl, propyl, butyl and amyl formates, acetates, propionates and valerianates being claimed as especially applicable. They propose to absorb the nitrous fumes in these organic liquids, subsequently removing them by distillation below the boiling point of the esters. Amyl acetate has the maximum solvent power, one part at room temperature being capable of absorbing nearly 20 per cent. of its weight of N_2O_3 and NO_2 , the gases being easily expelled by heating the solution below its boiling point while passing air or an inert gas into it. At the present prices of these esters, it is obvious that this process possesses no commercial interest.

The Jahn System

C. Jahn and the Sprengstoff Aktien Gesellschaft Carbonit have described a denitration process suitable especially for the spent acids from the nitration of aromatic bodies, where these bodies are present in considerable amounts in the waste acid. These substances (nitrobenzol, nitroacetone) which are liquid

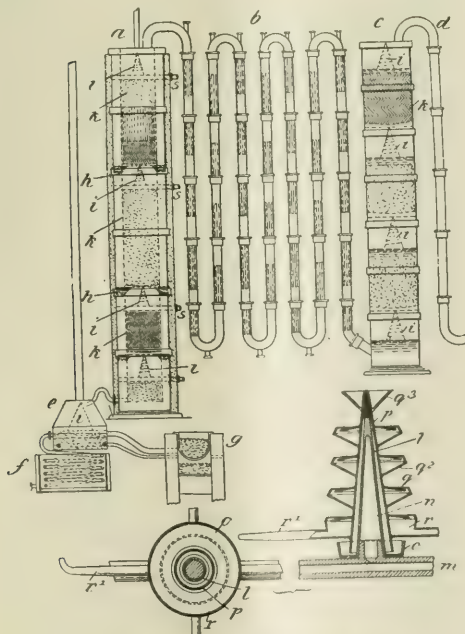


Fig. 2. Evers Denitrating System

when heated and are prone to deposit on the walls and adhere to the interior of the condensation towers so that in a short time the denitration becomes interrupted through choking.

The inventors claim that these drawbacks can be overcome by the installation of an apparatus which consists essentially of an inverted cone with a side outlet, so that the hot gases are caused to impinge upon the surface of a vessel containing either dilute nitric acid or water, with the result that any nitro-body present is condensed on the surface of the liquid and thus removed, some nitric acid also being absorbed, enriching the nitric acid in the system. The purified gases can then be conducted to the usual absorption apparatus.

Utilization of Waste Acids Without Denitration

In the pot method of nitric acid manufacture, nitrates, usually Chile salt-peter, are distilled with sulphuric acid, the nitric acid formed being condensed while the nitrates are converted into acid sulphates, known as niter-cake. Spent nitrating acids which do not contain too large an amount of water can be employed advantageously for the manufacture of nitric acid in place of the usual oil of vitriol, the nitric acid contained in the spent acid distilling over together with the nitric acid set free from the salt-peter. Any nitrous acids present are oxidized by a current of heated air.

This method has been practiced in some American nitro-cotton plants. The usual type of nitric acid plant, such as furnished, for instance, by the Buffalo Foundry and Machine Co. as designed by A. Hough, has been found suitable. Other uses for waste acids will suggest themselves; there being the possibility of employing them, if they contain but minimum amounts of nitric acid (as obtained from the nitration of liquid hydrocarbons to the mono-nitro stage), for the acidification of alkali fusions as in the manufacture of beta-naphthol. Such use, however, must only be made if the nitrous acid present is without material effect on the product manufactured, spent acids being, of course, entirely unsuited for the acidification of alkali fusions producing amino compounds.

Cast iron, brass and the like may be pickled by means of diluted spent acids containing but little nitric acid, niter-cake having been successfully used for this purpose. Large quantities of spent acids are used in the manufacture of acid-phosphate for fertilizer purposes.

Fortification of Spent Acids

Waste acids such as result from the manufacture of nitrocarbohydrates as nitrocellulose, usually contain such large amounts of nitric acid and sulphuric acid that their regeneration or "rejuvenation" can be accomplished by the addition of suitable amounts of strong nitric acid and oleum.

This method of fortifying spent acids is carried out on a very large scale, it being often possible to return all the otherwise wasted acid to the cycle of manufacture. The quantities of stronger acid which must be added are determined by calculation, in order to obviate the tedious and laborious trial methods formerly used. Not only must the acid be brought back to its original composition, but certain irregularities introduced as a result of the nitration reaction must be taken into consideration.

The calculations involved are often intricate and not readily comprehended by the average foreman in charge of nitration work. While no attempt is made herewith to describe all the meritorious methods in de-

tail, a concise statement of the principles involved may prove of value. The first essential is an accurate analysis of the spent acid as to its content in sulphuric, nitric, nitrous acids and water. The weight of the lot or batch of spent acid having been determined, it is apparent that this weight when multiplied by the percentage of any of the ingredients found by the analysis will give the weight of that particular component.

The following concrete example, in which all figures have been rounded off so that the calculations may be more readily followed, will make this clear.

Assume there is available 10,000 lbs. of spent acid containing 60 per cent. of sulphuric acid, 20 per cent. nitric acid and 20 per cent. water. If to this there are added 5,000 lbs. of 90 per cent. sulphuric acid and 2,000 lbs. of 90 per cent. nitric acid, what will be the composition of the resulting mixture? The calculations may be tabulated as follows:

	H ₂ SO ₄ Pounds	HNO ₃ Pounds	H ₂ O Pounds	Total weight
In old bath.....	6,000	2,000	2,000	10,000
From fresh acids.....	4,500	1,800	500*	7,000
In new mixture....	10,500	3,800	2,700	17,000

*The water in the acids added.

The percentage composition of the new mixture will then be weight of sulphuric acid in the new mixture divided by total weight of the mixture, which is 10,500 divided by 17,000, or 61.8 per cent.

Dividing the weight of the nitric acid and that of the water similarly, the composition is found to be 22.4 per cent. nitric acid and 15.8 per cent. water. Therefore the addition of the above named amounts of acid have raised the percentage of sulphuric acid by 1.8 per cent. of nitric acid by 2.0 per cent. and lowered the percentage of water by 4.2 per cent.

It is not always possible to attain the desired percentage of sulphuric and nitric acid in the resulting mixture by the addition of strong acids, especially where relatively large amounts of water are present, as the amounts of fortifying acids to be added would be enormous; hence the rectification is determined rather by trial, a kind of approximation method.

This procedure is undoubtedly still used in many nitrating plants, but the rapidity of the results obtained depend largely upon the guessing ability of the person entrusted therewith. A little study of the above calculations will show that it is possible to calculate directly the quantities of rectifying acids without the necessity of a trial, as the percentage composition of the finished new mixture is a constant, determined only by the process and material to be nitrated. There are several comparatively simple graphical methods in use which deserve mention.

In the May, 1919, number of *Caoutchouc et Gutta-percha*, Clement and Riviere have described a complicated but accurate formula for the calculation of acid baths, an abstract being in the *Moniteur Scientifique* for 1913, Vol. 78, p. 73. Another meritorious method is that of the late Leon Redpath, which is based on two superposed nomographical charts, from which the weights of acid to be added can be read off at once. This method was first published in 1911 in E. C. Worden's "Nitrocellulose Industry." H. Schwarz writing in the *Zeitschrift für das gesamte Schiess und Sprengstoffwesen*, 1913, Vol. 8, p. 288, states that he has obtained excellent results with this method and describes it in detail. R. Fowler (*Journal of the Society of Chemical Industry*, 1919, Vol. 38, p. 34-T) details a graphical method evolved by him, while P. Craven has constructed a slide rule for solv-

ing these calculations. (See *Chemical News*, 1918, Vol. 117, p. 217.)

Concentration of Sulphuric Acid

In the foregoing processes, except where the whole of the spent acid is utilized, weak sulphuric acid is produced, and if this is not conveniently utilizable in or near the plant, concentration must be resorted to. A large number of methods for accomplishing this have been proposed, although many of them are only of passing interest, the more modern processes, such as the Gaillard tower system, Silica cascades and the like rapidly replacing the lead, glass, platinum and porcelain stills in use a few years ago.

Cast iron resists the action of sulphuric acid of a concentration greater than 93-94 per cent., such strength being obtained by concentration in silica or acid-resisting metal pans in cascades. Concentration is often completed by allowing the acid from the cascades to flow through large cast iron pans heated directly, acid as high as 98 per cent. being obtainable, the only precautions necessary being to take precautions to prevent a concentration of sulphuric acid below 94 per cent. when the process is interrupted.

In one system a large pot of strong acid is heated almost to the boiling point, a stream of the weaker acid being allowed to slowly run on to the surface of the boiling acid, the concentrated acid being periodically drawn off by a syphon-like arrangement from the bottom of the pot, suitable provisions for the removal of sludge being made.

Concentration of sulphuric acid in lead, glass, platinum and porcelain is practically a thing of the past, the only apparatus belonging to this category in use today being the fused silica cascades, such as Vitreosil, which are very satisfactory and highly resistant to acid and sudden changes in temperature, and only limited by their size, so that for very large requirements the Gaillard tower system is to be preferred. Cascades of Duriron, Tantiron, Neutral-sien and Buffalo-cast metal also have found favor.

Gaillard Tower System of Sulphuric Acid Concentration

The most successful apparatus yet introduced for the concentration of sulphuric acid is without doubt the Gaillard tower, which works on an entirely novel, simple and ingenious principle. The apparatus consists of an empty tower of volvic lava or acid-resisting bricks, from the base of which a current of hot gas from a coke generator is directed upwards. Meeting this current is a fine spray of the acid to be concentrated, each drop of the acid being exposed to the influence of the dry, hot gases, thus being effectively deprived of its moisture, the strong acid collecting in a lead saucer similar to that at the base of a Glover tower.

The hot gases issuing from the top of the tower entrain considerable amounts of acid in the form of a fine mist, which is recovered by passing the gases through a smaller lead tower, called a recuperator, down which a part of the acid to be sent to the main tower is sprayed, the gases then passing through a filter of coke. The precipitation of the acid mist by means of the Cottrell precipitator has been tried out successfully. The Gaillard tower was adopted by the large British acid plants at Queen's Ferry and Gretna, one installation comprising a tower 47 ft. high, the lower 13 ft. 6 in. being 8 ft. 6 in. diameter while the rest is 9 ft. 6 in., the gases being conducted to the recuperator, which consists of a 30-ft. lead tower 5 ft. in diameter, through 24 ft. stoneware pipe covered

with 8-lb. lead. The scrubber consists of a box 30 ft. x 16 ft. x 11 ft. lined with 10-lb lead, packed with coke on an acid-proof tile grid-work, circulation of the gases through the apparatus being effected by a Kestner high-pressure fan 16 ft. in diameter.

Kessler System

The first really successful apparatus based on this principle was that of J. Kessler, and has been installed in a number of works. The underlying principle involved is that a current of heated gas is brought into intimate contact with a surface of liquid sufficiently large to cause a rapid reduction in the temperature of the gas, whereby the latter becomes completely saturated with moisture and acid vapor. Under these conditions the acid may be concentrated far below its boiling point, a temperature of 170° C. being sufficient to produce 95 per cent. acid.

The Kessler apparatus in general comprises the following: The lower part, where the gases enter at a temperature of 300-450° C., leaving at 150°C., is called a "Satuxex," and consists of a shallow trough of volvic lava or the like, enclosed in a thick lead jacket. Between the bottom and cover of the Satuxex are several thin partitions which cause the heated gases to pass closely over the surface of the acid, and, when passing from one of these flues to the other, through the acid itself, thus being rapidly cooled.

The steam and acid vapors from the Satuxex pass to the upper part of the apparatus, called a Recuperator, consisting of three lower stone plates and two upper lead plates, arranged so as to form a bubbling column like those in a rectifying still. Each plate is provided with 100 holes with slightly raised margins, so that a layer of acid always remains on it. The acid to be concentrated is fed to the recuperator, overflowing from plate to plate until it reaches the satuxex. The concentration is stated to be as high as 98 per cent., and impure Glover acid may be used.

An almost endless number of other processes for the concentration of sulphuric acid have been proposed, among them being suggestions for the use of electrically heated grids over which the acid passes; the use of vacuum stills, and various types of internally or externally heated tubular apparatus. The essential points in the concentration of sulphuric acid are the source and cost of the heat required to remove the water, and as the specific heat and heat of vaporization of sulphuric acid changes with the concentration, the calculation of cost is quite complicated. An excellent article on this phase of the subject has been contributed by A. Porter in *Transactions of the Faraday Society*, 1918, Vol. 13, part. 3.

The development and perpetuity of our chemical industries are intimately interwoven with the problems of utilization of nitric and sulphuric acids. It must be remembered that the majority of both the propulsive and shattering explosives used both in the warlike arts and in the peaceful pursuits are nitro-derivatives, and require both nitric acid and sulphuric acid in their preparation; and there can be no successful manufacture of many pharmaceuticals, medicinal chemicals, toilet preparations, dyestuffs and photographic developers without the use of comparatively large amounts of these acids.

Everywhere is a genuine effort being made toward the conservation of our resources and their exploitation upon a sound, economic basis. With nitric and sulphuric acids, therefore, the keystone of a manufacturing chemical industry, increased attention is being devoted to their economical recovery, employing the methods and practices as outlined above.

Conditions of American Potash Production

By Frederick W. Brown

Executive Secretary, United States Potash Producers' Association

THE permanent tariff bill, reported last week by the Ways and Means Committee, carries a five-year diminishing duty on muriate and sulphate of potash, kainit, wood-ashes and beet-root ashes, and all crude potash salts not specially provided for. For the first two years the duty will amount to $2\frac{1}{2}$ cents a pound of potassium oxide in the salts, 2 cents for the third year, $1\frac{1}{2}$ cents for the fourth year, 1 cent for the fifth year, and nothing thereafter.

The American producers went to the Ways and Means Committee this Spring and frankly and openly laid their cards down on the table. They presented all the facts of their case, in the fixed belief that no man, unless already hopelessly biased, could examine those facts and deny the legitimate claim of the producers to protection. They asserted their right to be considered an infant industry capable of rapid growth to independent stature. They asked only a moderate degree of protection. They gave their unqualified promise, if this protection were granted, to do their utmost to make this country forever independent of Europe in the matter of potash.

It is a source of gratification to these producers that, in the face of an insidious propaganda carried on by certain journals and newspapers with the design of discrediting their statements, the Committee has accepted their testimony at face value and put in the bill the duties exactly as requested. Claiming to be an infant industry in the honest intent of that term they asked only for temporary protection. Firm in the belief that they could rapidly reduce their costs if allowed to live at all, they agreed to a diminishing scale of duties, which in five years' time should leave potash on the free list. Knowing that costs of production in Europe have advanced, they asked only the very moderate tariff duty of fifty cents a unit of K_2O for the first two years.

What will be the result if this bill becomes law? In the first place it will not save all the American plants. Some of the weaker brethren have already given up the struggle and others undoubtedly will be forced to. Further, it will not have the effect of drawing new capital into potash production, which a straight tariff duty with no limit as to time would have had. Five years of diminishing protection is a very brief time in which to work out the financing and operating difficulties in a new venture. However, there is reason to expect a definite expansion of the business along lines where the technical problems largely have been conquered.

In Nebraska the existing plants undoubtedly can care for all the available brine and further expansion can hardly be looked for. At Searles Lake, California, and Salduro, Utah, a large expansion might, however, take place, and plants designed to operate along the lines which the pioneers on these two developments have tested, might easily be put on a firm basis within the time limit prescribed in the bill.

So far as the larger plants already in existence are concerned, the provisions of the bill will mean the difference between sudden death and a healthy life. With the uncertainties of the situation removed, the operating companies can face the future with some assurance. This uncertainty has been the strongest

factor in hindering the development of the industry since the armistice. It has taken a wise general manager to foresee what his plant would be doing, three months in advance, at any time since the Fall of 1918. In the face of such uncertainty it would have taken a lax board of directors to vote additional heavy outlays for new equipment even though it was a certainty that such an expenditure would reduce costs of production.

If this bill becomes law the most important factor in this uncertainty will be removed. We shall, to a great degree, know where we stand, what we can expect and what we must face.

This tariff will not do everything for the industry. The rates are too low and the time too brief, but it will greatly simplify the problem, because everything else is dependent on protection. It is true that plant costs must be reduced. But capital to install the necessary changes cannot be raised till there is some assurance that the cheaply produced and cheaply transported potash of Europe will not be permitted to overwhelm the American producers at the start.

Also freight rates must be reduced on domestic potash. Some reductions have been granted and others are now under consideration, but hitherto the railroad man's excuse for inaction or delay on applications for reductions has been that with a high enough tariff the industry would not need lower freight rates. It will be possible now to show him that the tariff will not do all that is necessary and that he also must help. And this he is the more willing to do if through tariff protection he can foresee the development of an industry which as time goes on will bring to his line a steadily increasing tonnage to be hauled.

As for the immediate future this much may be said. Stocks now on hand in this country aggregate probably a little more than 50,000 tons K_2O . Anything like a normal demand this coming Fall and Winter will deplete these stocks very rapidly and furnish a market for additional supplies. The farmers have cut their costs of production this year quite drastically. Labor has been plentiful and relatively cheap and fertilizer bills have been reduced to a minimum. As a result, when they market their crops this Fall, even with the present level of prices for farm products, the farmers are going to find they have made some money. That being the case we can feel reasonably assured of a demand for fertilizer this Fall and next Winter far in excess of the amount bought during the season just passed.

Metcalf & Eddy, consulting waterworks engineers, retained by the city of Milwaukee, Wis., to determine the advisability of constructing a city filtration plant, in a report just submitted, confirm the contention of a committee of local chemists, of which George A. Prentiss, engineer of tests, C. M. & St. Paul R. R., is chairman, that preliminary to the construction of a filtration plant chemical study of the water should be made over a period of months, before beginning construction of the plant as recommended by another consultant. The Milwaukee chemists comprising the committee are elated at this confirmation of their advice in a matter involving the health of half a million population.

Agricultural Insecticides

II. Raw Materials and Methods of Manufacture.

By R. R. Henderson

Consulting Chemical Engineer

ARSENATE of lead constitutes the main bulk of the present insecticide business. The man who occasionally notices a few pound packages of this article in his seed store or at the druggist's usually has the idea that the manufacture of this product is a sort of one-horse affair. The one-pound package constitutes a very insignificant part of the total product manufactured. Arsenate of lead is packed in 300-pound barrels, 100-pound, 50-pound and 25-pound drums and 10, 5 and 1-pound cartons. By far the largest amount of sales is in the 100-pound drums.

Arsenate of lead was prepared originally by the interaction of lead acetate and sodium arsenate (see previous article in May 1921, CHEMICAL AGE).

The requirements for a high-grade product are that it shall contain the maximum possible amount of total arsenic and the minimum of arsenic in water-soluble form, shall mix readily with water and stay mixed without too rapid settling in the spray tank, shall contain no grit likely to clog the fine spray nozzles and stick well on the foliage.

The first arsenates of lead produced commercially contained on the dry basis about 25 per cent. total arsenic oxide. They were known in the trade as "ortho" or "tri-plumbic" arsenate of lead. It was thought by some for a long time that this was the only kind of arsenate of lead that could be made.

The writer has on his desk the copy of a letter written in January, 1909, in which the president of one of the country's important chemical corporations is quoted as stating emphatically that an arsenate of lead with a higher proportion of arsenic could not be produced. However, someone who had not yet heard the above statement and didn't know "it could not be done" went ahead and did it, and now most of the products on the market contain better than 32 per cent. arsenic oxide.

Another change that is considered an improvement by a majority of users is an increase in the bulk of the material. Most of the arsenate of lead on the market at present contains nearly twice as many cubic inches per pound as that of a few years ago. This material mixes with water very readily and holds up better in the spray-tank. There is, however, a doubt expressed by some as to whether it actually sticks better to the leaves and has the same killing power as the more dense material. It would appear that there is still some room for argument on this question.

The larger part, probably more than three-quarters, of the arsenate of lead produced in this country is made by the reaction of arsenic acid with litharge.

Simple as the process used would appear from a chemical standpoint still there are several features that require careful attention to produce a high-grade product. Wooden tubs equipped with heavy agitators similar to those used in dry color manufacture are employed. Water is run into the tubs and heated by live steam. Litharge is shoveled in and a small amount of nitric or acetic acid added. The arsenic acid is then run in and the reaction forming arsenate of lead takes

place, the yellow color of the batch gradually turning to a clear white. The batch is then tested to make sure there is no large excess of litharge or lead salts present and that there is no free arsenic acid.

Some plants have had considerable difficulty in getting the reaction to take place within a reasonable length of time or with any regularity. One batch would finish in an hour while another might take several days and in some cases batches have been stirred for a week with no reaction.

The reason for this was discovered finally and it was so simple that on looking backward it seems strange the problem should have gone so long without solution. The whole difficulty was in the order in which the various materials were added to the tank.

Those plants getting uniformly quick results were adding the materials in the order, viz., water, litharge, nitric acid, arsenic acid. Those having difficulty were using some other order whereby the arsenic acid came

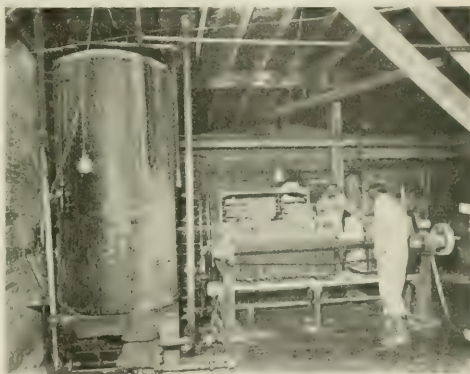


Fig. 1. Typical Arsenate of Lead Filtering Installation

in contact with the litharge before the nitric or acetic acid was introduced.

It has been proposed in explanation of this that where the first order is used the nitric acid dissolves some of the litharge forming a mixture of litharge, lead nitrate and water. The arsenic acid then added reacts with the lead nitrate forming arsenate of lead and freeing nitric acid, which again attacks more litharge to form more lead nitrate and this continues until the litharge is all used up.

But where the second order of addition is used the arsenic acid comes in contact with only litharge and water when it is first introduced into the tub. Litharge being only very sparingly soluble in water allows just a film of arsenate of lead to be formed around each particle of litharge and then the action stops. The subsequent addition of nitric acid is so dilute that it cannot dissolve through this film, and the litharge thus protected forms no lead nitrate until through long-continued agitation the films are broken.

Quick reaction is essential to economic production in order to obtain maximum output with a minimum amount of machinery. To obtain a material which is extremely light and fluffy when dried and powdered is a problem mainly of dilution during pre-precipitation.

*The present article on "Agricultural Insecticides" concludes the discussion of "Raw Materials and Methods of Manufacture." The August installment will cover "Distribution, Present Status of the Industry, and Problems to Be Solved."

The more dilute the solutions the more bulky the precipitates obtained. In some plants, especially previously to the introduction of these very bulky arsenates of lead, it was the practice to bolt the material through fine silk and grind the tailings in a mill, repassing them again over the bolting silk.

A very amusing incident happened in connection with the first introduction on the market of the present very light and bulky arsenate of lead. The first producer of this fluffy product, which required a package nearly twice the ordinary size, was a large paint manufacturer. In drying their first runs of this material this company happened to use one of their regular dry color dryers and some trays which had previously been used for a red pigment. These trays were not cleaned thoroughly and the result was that the new arsenate of lead when placed on the market was a very pale pink instead of the usual clear white. Competitors obtaining samples of this new material were of course anxious to find out how this unusual bulk and fluffiness were obtained, and noting the pink color, immediately jumped to the conclusion that this had something to do with it and were extremely puzzled. It

the market price of acetic acid allows it. This consists in forming arsenate of lead by precipitating basic lead acetate with arsenic acid.

The basic lead acetate is prepared by passing acetic acid over spongy lead in towers, with a current of air. The "lead liquor" is then run into the mixing tub and precipitated by the addition of the arsenic acid. The precipitate is filtered off, and in one of these plants the solution is used again for dissolving more lead.

The precipitate obtained by any of the above methods is washed either by decantation or in a washing filter-press. The modern bulky arsenate of lead makes washing by decantation difficult as the precipitate settles in the tubs but a few inches in 24 hours. It is pressed in the filter-press to a water-content of about 60 per cent.

Fig. 1 shows a typical filtering installation for arsenate of lead where the material is later to be dried on trays in a compartment dryer. The arsenate of lead is run from the mixing tank into the large iron pressure-tank shown at the left. The inlet valve is closed and compressed air applied, thus forcing the mixture into the 24-in. Sperry filter-press. The clear liquid

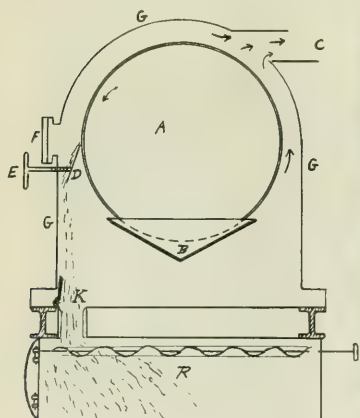


Fig. 2. Cross-Section and Perspective Views of Vacuum Drum Dryer for Insecticides

was quite a mystery for some time, and doubtless this appearance in print will be the first information many will have had as to the reason of that peculiar pink arsenate of lead.

It was some time before the relation that dilution, temperature and speed of reaction held to physical appearance of the precipitate became common knowledge to the insecticide manufacturer. To obtain a maximum arsenic-content requires that the reaction go to completion and that there be no excess litharge left in the batch. If this is done and the correct calculated quantity of arsenic acid is employed, the arsenate of lead should be of the required strength. For freedom from water-soluble arsenic in the finished product, care must be taken that the arsenic acid used contains very little arsenious oxide and that the precipitate is washed well before drying.

Other chemical reactions are used by a few firms for precipitating arsenate of lead. Basic lead carbonate or "white lead" may be employed instead of litharge in the preceding method. For the best results "old Dutch process" white lead is employed. The other details of the method are very similar to those wherein litharge is used.

Another method is employed by two concerns when

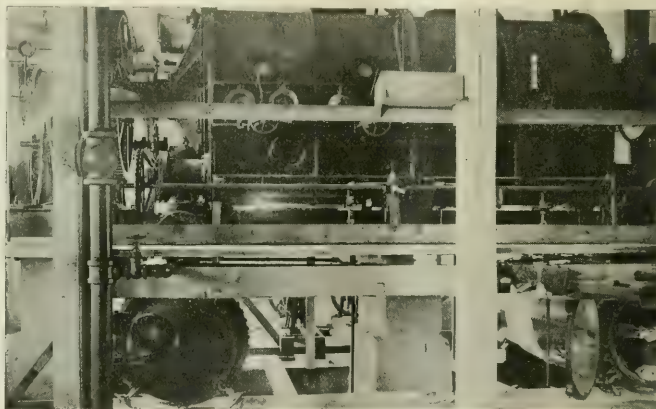
passing through the press is collected by the steam pump shown just below the pressure-tank and forced back to the mixing room, where its acidity is again used in the next batch of arsenate of lead.

An interesting feature of this special installation is that the filter-cake is pressed so hard that it is possible to cut it horizontally through the middle and by a peculiar twist of the hand which the workmen have acquired through practice, drop the cake in two layers on trays which are only half the size of the original uncut cake.

Other forms of filtering, e. g., the Sweetland self-dumping press, are employed in some plants. In this case, however, the cake cannot be dropped directly onto the drying trays but must be spread on later from the storage pit or box.

After filter-pressing the press-cake is then dried in some form of tunnel or compartment dryer. After drying the cake is passed through a disintegrator, which reduces it to a fine white powder.

In an effort to do away with the filter-press and personal contact with poisonous products in cleaning the press and transferring the trays to the dryer and thence again to the disintegrator, other methods of drying have been tried.



One of the first experiments was with a vacuum drum dryer, Fig. 2. This apparatus consists of a revolving steam-heated drum which at its lowest point dips into a trough containing the liquid to be dried, the whole enclosed in a casing from which the air has been exhausted.

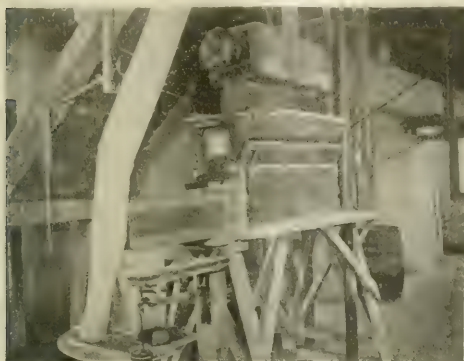


Fig. 3. Sifting Equipment for Insecticides

The drum in revolving picks up a thin layer of the material and the moisture is expelled during part of one revolution so that when the material is scraped from the drum by a knife located just above the point where the drum dips into the mixture again it is in the form of a dry powder. From the knife the powder falls to a conveyor which carries it to a receiver which also is under vacuum. Fig. 2 shows this dryer operating on arsenate of lead.

When new and not run at too high a speed this apparatus gave very good satisfaction, and being entirely enclosed was highly thought of by all health authorities. There were, however, several points in the design of this first machine as installed which finally necessitated its abandonment. It would appear though that a dryer of similar operating principle, but with some changes in design ought to be the ideal apparatus for the insecticide business. Since then the atmospheric drum dryer has been tried for drying arsenate of lead and arsenate of calcium and has been found quite satisfactory, except for the dust rising from it.

The atmospheric drum dryer operates similar to the vacuum drum described above except that it has no outer casing and operates at atmospheric pressure. It therefore does not require quite the skill in operation as does the vacuum apparatus.

However, the atmospheric drum dryer requires care in installation and frequent mechanical inspection to insure its satisfactory operation at full efficiency. The relegating of this supervision to unskilled labor has lead one or two firms to conclude that the drum dryer cannot be satisfactorily used on insecticides.

The spray dryer has also been tried in a small way for drying insecticides. This process consists in introducing the water mixture as a fine spray into a current of heated air which dries the finely divided product almost instantly. While working very satisfactorily on milk, egg albumen, etc., which must be dried with great care to prevent chemical changes taking place, it has not yet been looked on with much favor for drying cheap materials which must be handled in large quantities.

When drum dryers are used the material is recovered in the form of a fine powder and further treat-

ment is not absolutely necessary. However, some firms as an extra precaution pass the material through a disintegrator or over screens to prevent any possibility of small lumps or coarse particles entering the finished product.

Fig. 3 shows the sifting arrangement at one plant, which consists of a spirally constructed brush which conducts the arsenate of lead along a trough of steel-wire screen. The material falling through is conducted by a conveyor directly to the barrels and 100-pound drums placed on the scale shown in the figure. The white-cloth duct shown in the foreground is under slight suction and is used for conveying away any dust rising from the drums.

Small packages of insecticides are packed both by hand and with automatic machinery. The chief difficulty encountered in designing automatic packing machinery for arsenate of lead and arsenate of calcium has been that these compounds will not flow readily from bins and through spouts but stick and arch-over. Even bins and cone receivers with their sides at as great a pitch as 75° will not always deliver properly.

The material also is so light and fluffy that it is necessary to jar or compress it while filling. Figure 4 illustrates an automatic packing machine which was first used on paris green and which operates with considerable success providing the small spouts are kept constantly filled by some horizontal screw-conveyor device through which a constant flow of the powdered material passes. If an attempt is made to feed the spouts direct from a large storage-bin frequent stoppage is bound to result.

The operation of the machine is as follows: The cartons are placed on the endless belt at the extreme right of the machine as illustrated. One at a time they are released automatically and travel to a position underneath the first delivery spout. Here enough material is discharged to fill the box nearly full, but no automatic weighing takes place at this point; merely an approximate volume of powder is delivered.

The carton then passes along toward the next spout and on its way is agitated and the powder jarred down by a device situated underneath the belt.

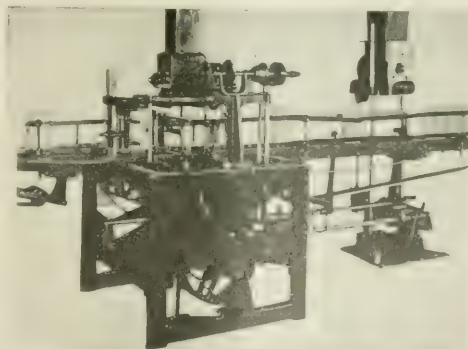


Fig. 4. Automatic Weighing Machine for Insecticides

Arriving at the second spout the carton is pushed from the belt onto the platform of a small scale and sufficient powder is discharged from the spout to make up the required weight at which point the flow is cut-off automatically. The carton is then pushed back onto the endless belt which conveys it to the point where the tops are sealed.

Arsenate of Calcium

Arsenate of calcium is made by combining arsenic acid with lime. In most plants calcium oxide or lime is used. A few, however, prefer to use the hydrated lime.

If calcium oxide is used it is first slaked and the milk of lime is run into the mixing tub. Hydrated lime may be weighed and dumped directly in the tub partly filled with water. The arsenic acid is then run in. When the tests show the reaction to be complete and no free arsenic acid present the precipitate is allowed to settle and is washed, filtered, dried, ground and packed similarly to arsenate of lead.

This material is not produced as near chemically pure as is the arsenate of lead. It is somewhat more soluble than the lead salt and to counteract this a slight excess of lime is allowed in the batch so that ordinary commercial arsenate of calcium really consist of a mixture of arsenate of calcium and lime.

Miscellaneous

The foregoing gives a general idea of the methods employed in preparing the most commonly used insecticides. Arsenate of lead is the leading factor in this business with arsenate of calcium rapidly gaining in popularity for many purposes.

Outside of the products mentioned there are many others employed for special uses or in small amounts.

As a substitute for a dry lime sulphur, sodium sulphide has been used. Barium tetrasulphide also has been proposed and manufactured on a small scale. Zinc arsenite has been made and marketed in comparatively small amounts and only very recently one firm has started the manufacture of magnesium arsenate. Potassium and more recently sodium cyanide are used for fumigation of stored grains, flour mills, and orange trees. It is not, however, manufactured in plants devoted to the insecticide industry as its original and principle use is in the metallurgical industries.

The Chemical Age

By Caleb R. Layton

Member of Congress from Delaware

THERE is no schedule in this bill* of greater importance than the chemical schedule. In all the past history of legislation there has been no schedule, not excepting that of iron and steel, that so intimately concerns us as a people, for this schedule embraces not only those products of the laboratory required in the manufacture of textiles and the colorings required in all other forms of our industrial life, but a schedule through the mastery of which we will combat disease, conserve the health of the people, and adequately defend them in time of war.

Every epoch of civilization has been characterized by some new discovery or activity which stamped it with a special significance. Most significantly is this styled the CHEMICAL AGE. Geological history itself is differentiated into ages by reason of some prevailing and predominant characteristic, either in atmospheric or animal or vegetable existence. The Carboniferous age made it possible for us millions of years afterwards to enjoy the potencies created by the tremendous growth of the vegetable matter which characterized it, and which gave us those inestimable possessions such as coal, gas, coal tar, and thousands of resultant products from these raw materials.

When one looks at the crude, ill-smelling stuff, and remembers what has been produced already therefrom, the mind is apt to regard it as some magic thing of illimitable and amazing potentialities. There is nothing in this whole tariff bill so pregnant with influence upon the future progress, power, and safety of our country as this schedule which relates to coal tar and to synthetic chemistry which has developed to the high plane it now occupies in science.

I believe that we should give every fostering care to the things comprehended in this schedule in order to develop the highest synthetical chemical knowledge of any nation in the world. The acquisition of this knowledge means the acquisition of the greatest modern power. Loath as I am to involve Government intervention in what should be individual enterprise, I am not sure but what the Government itself in this matter would be wholly justified in appropriating money for the purpose not only of securing the greatest chemists of the world but in developing them as

well out of our own genius, thus encouraging the development of synthetic chemistry so as to insure its own supremacy among the nations of the world—notwithstanding the German mind laughs at this, claiming that we lack devotion and the necessary enthusiasm for such work.

Just as the strength and influence of every nation in the past have been measured by its production of coal and iron, so will the power, the safety, not to say the welfare and happiness of our country be measured in the future by its knowledge of synthetic chemistry.

The iron man has been the commanding figure of our civilization up to this time. In the future it will be the chemist who works quietly in his laboratory and shifts the molecular combinations obtained from coal tar from one angle of the hexagon to another, thereby changing at will the essential qualities of the product, and so, by an almost inexhaustible permutation, makes an infinite variety of things so comprehensive in their usefulness and need that health, road building, housing, textile manufacturing, physical adornment, objects of art which delight the senses, agriculture, photography, national defense, and an infinite number of other things are included within the scope of his power.

When one reflects that the first patent granted for "making pitch and tar out of pit coale" was in 1681, the year that marked practically the first attempt to grapple with the mysterious heritage of the Carboniferous age, and that the value of this tar was not recognized until two centuries later, we can see how slow the scientific world was in comprehending the inestimable and essential potencies of this wonderful substance, compared to which there is nothing like it in the world.

It must not be forgotten that the analytical chemist is now standing only on the threshold of a storehouse of inexhaustible possibilities—on the borderland of a vast domain of infinite discovery. The elements with which he is now becoming familiar afford innumerable vistas of beneficent and endless actualities. There seems to be in truth no end to what reasonably may be expected from his efforts in the future, as he gets more and more familiar with a substance that apparently possesses in large measure all the energies of the earth.

*From address in the House of Representatives, July 9, in connection with the chemical schedule of the government tariff bill.

Carbon Black Production from Natural Gas

By E. G. Sievers

U. S. Geological Survey

THE United States Geological Survey first compiled statistics on carbon black for the year 1919, when the quantity produced was 52,056,940 pounds, having an estimated value of \$3,816,000. This output was made by 36 plants, operated by 16 producers. These statistics were obtained from reports filed with the Geological Survey by the producers, and the value given is computed from the prices received, which range from 3 cents to 27 cents a pound. The total average price for 1919 was 7.3 cents a pound. The output of carbon black in 1918, according to estimates made by the Bureau of Mines, was 43,500,000 pounds. The output in 1919 was thus about 22 per cent. greater than in 1918. The average daily production in 1919 was about 144,600 pounds; that in 1918 was 120,830 pounds.

Natural Gas Consumption

About 49,896,200,000 cubic feet of natural gas was consumed in the manufacture of carbon black in 1919, as compared with 45,000,000,000 cubic feet in 1918. The daily capacity of the plants in volume of gas treated ranges from 72,000 cubic feet to 18,360,000 cubic feet, and in quantity of carbon black produced it ranges from 90 pounds to 22,900 pounds. The yield of carbon black per thousand cubic feet of gas ranges from 0.65 pound to 2 pounds, but the average yield during the year for all states was about 1.04 pounds. Of the plants operated in 1919, 6 produced an average yield of less than 1 pound of carbon black to 1,000 cubic feet of gas, 17 plants from 1 to 1.2 pounds, 11 plants from 1.3 to 1.6 pounds, and 2 plants from 1.7 to 2 pounds.

Distribution of Carbon Black Manufacture

West Virginia was the leading producer, and Louisiana, which has made a very rapid growth in this industry during the last few years, was second in rank. The producing states, named in the order of production, are West Virginia, 57 per cent. of the total output; Louisiana, 27 per cent.; Wyoming, 8 per cent.; Oklahoma, 3 per cent.; Kentucky, Montana and Pennsylvania combined, 5 per cent.

The carbon black industry migrates according to the available supplies of natural gas. West Virginia has always been the center of manufacture, but Louisiana and Wyoming have made rapid growth. As natural gas is an ideal domestic fuel the consumers demand that it be reserved for domestic uses, and the carbon black industry, therefore, has migrated to localities where there are abundant supplies of natural gas for which there is only a small market or no market at all.

The Monroe gas field, in Louisiana, one of the largest in this country, has been a favorable location for carbon black plants, for it is remote from large cities and towns and supplies but little gas for domestic uses, and the gas is sold at a fairly low rate, so that the carbon black industry has there become well established. The producers are now installing plants that remove the gasoline from the gas before it is consumed in the manufacture of carbon black, which is another means of conservation.

In Wyoming the conditions are somewhat like those in Louisiana. The general market for the gas pro-

duced there is small, so that the carbon black industry has been developed until Wyoming has surpassed Oklahoma and assumed third rank among the producing states.

The following table shows the production of carbon black in the United States in 1919:

Carbon Black Production from Natural Gas in the United States in 1919.

State	No. of plants	Carbon Black Produced			Gas Used	
		Quantity (lbs.)	Value	Average price (cents)	Quantity (M cu. ft.)	Average yield per M cu. ft. (lbs.)
W. Virginia	23	29,925,414	\$2,538,119	7.8	23,117,332	1.3
Louisiana	7	14,021,606	933,334	6.6	20,291,021	1.7
Wyoming	2	4,868,947	231,747	4.7	4,306,153	1.1
Montana	1					
Oklahoma	2	2,922,274	244,726	8.3	1,954,129	1.4
Kentucky	1					
Pennsylvania	2	315,500	48,114	15.0	227,700	1.3
	36	52,056,941	\$3,816,040	7.3	49,896,233	1.04

Carbon black is an amorphous form of soft carbon produced by the incomplete combustion of natural gas. It is sometimes confused with lampblack, which is made by burning oil or some other raw material, and which differs from carbon black in molecular structure and tinctorial strength, as well as in quality and in use. Its lightness and fineness, freedom from gritty particles, miscibility with oil, intensity of color, and remarkable covering power when mixed with other materials are among its essential qualities.

Printing Ink

Carbon black was first made commercially in this country about 1864, when it was first used in making printing ink. The growth of the industry has been stimulated by the rapid increase in the publication of books and newspapers, which demand a constantly increasing supply of carbon black for the manufacture of printing inks adapted to fast press work. The modern rotary printing presses now used by daily newspapers and printing establishments require an ink that will dry rapidly and yet permit the presses to be operated at a high speed—an ink that will flow freely, possess great covering power, and make an instantaneous and legible impression—and an ink having all these qualities can be made by using carbon black. One pound of carbon black mixed with eight pounds of oil and other chemicals will produce enough ink to print 2,250 copies of a sixteen-page newspaper of ordinary size or 90 copies of a 300-page octavo book. Prior to 1864 lampblack was used in making printing ink, but as carbon black proved to be superior for this use it rapidly displaced lampblack. About 25 per cent. of the total annual output of carbon black is now incorporated in printing ink.

Pneumatic Tires

The World War had a direct influence on the carbon black industry. At the beginning of the war the importation from Germany of oxide of zinc, which was incorporated in automobile tires, was curtailed. It was soon found, however, that the use of carbon black in rubber tires, both pneumatic and solid, for automobiles and trucks added to the life of the tire. The addition of carbon black has given the rubber greater toughness and resiliency, better traction, and a longer mileage. It has increased the tensile strength and the elasticity

of the tire about 25 per cent. and 10 per cent. respectively.

The latest figures published by the Bureau of Public Roads show that the number of commercial motor vehicles—such as motor trucks and automobiles—not including motorcycles, registered in 1920 was 9,231,941, which would require at least 36,927,700 tires, and to this the additional number required to replace worn-out tires should be added. Carbon black has thus become widely used in the rubber industry, which consumes about 45 per cent. of the output. The advantages of carbon black in making rubber tires have been established, but whether it is irreplaceable is still a matter of opinion among chemists.

Miscellaneous Uses

About 10 per cent. of the carbon black produced is used in the manufacture of stove polish, about 1 per cent. in phonograph records, and about 2 per cent. is distributed among miscellaneous uses, including black leather, black and gray paper, bookbinders' board, buttons, carbon paper, carriage cloth, celluloid, electric composition insulators, cement colorings, crayons,

glazed paper, Chinese and India inks, marking and stenciling inks, artificial stone and black tile, paint, shoe polish, tarpaulins, type ribbon, varnish, etc.

Between 15 and 20 per cent. of the output is exported. Before the war about one-third of the output was exported, but owing to unstable conditions the export trade has not resumed its normal proportions. Owing to the increased use of carbon black in the manufacture of rubber tires in this country, however, less of the product will probably be available for export.

The following table, summarizing approximately the distribution of carbon black in 1919, is prepared on the assumption that the same proportion of the distribution by uses prevailed in 1919 as in 1918, as estimated by the Bureau of Mines:

Use	Per Cent.	Quantity
Rubber industry	45	23,425,000
Printers' ink	25	13,014,000
Export	17	8,849,500
Stove polish	10	5,205,500
Miscellaneous	3	1,562,000
		52,056,000

Anthraquinone Production by the Thatcher Process Co.

THE importance of vat colors of which anthraquinone is the basis of the largest class and in the production of which the American dyestuff industry admittedly has been deficient, lends interest to the enterprise of the Thatcher Process Co. in beginning the electrolytic manufacture of anthraquinone in its new plant at Syracuse, New York.

This intermediate is derived from anthracene, the difficulty in securing adequate supplies of which the U. S. Tariff Commission in its survey of the coal-tar chemical industry for 1919 declared to be the most important and fundamental problem awaiting solution in the dye industry. The Commission stated that when a sufficient supply of anthracene is secured an adequate production of alizarin and vat dyes will soon follow.

The fundamental difficulty has not been primarily an actual lack of anthracene in the tar, nor are there purely technical difficulties in its recovery, but rather the fact that its removal has left the pitch so hard that it did not find a ready market in this country. Any method of recovering anthracene which seriously disturbs the marketing of the other larger fractions of the tar, especially the pitch, would make the anthracene so expensive that the dyes derived therefrom could not be made on a competitive basis. In England and Germany large amounts of hard pitch were used for the briquetting of coal dust and coke breeze, but this industry is little developed in the United States. England shipped considerable amounts of crude anthracene to Germany before the war.

Whether the problem would be solved by the tar distillers or by the development of a synthetic process for making anthraquinone (the most important intermediate made from anthracene) from raw materials now available in adequate quantity, the Commission said could not be determined at that time. Over 4,000,000 pounds of pure anthracene would be required to manufacture alizarin and vat dyes to the amount of the average annual import from 1912 to 1914 inclusive.

This problem to which the Commission calls attention, the Thatcher Process Company now claims to have solved. They have a method of extraction, we are told, whereby the removal of the anthracene leaves

the pitch in as marketable a condition for all American uses as it heretofore has been without the removal of the anthracene. Since there has not been the slightest question of the existence of sufficient anthracene in this country, provided it could be extracted and leave the larger fractions of the tar in a marketable condition, it would seem that the Thatcher Company has accomplished a most important result which cannot fail to be of the greatest benefit to the American dyestuff industry, if their method is as claimed.

Production of anthraquinone by the Thatcher Process Co. is based on the use of an electrolytic cell designed and patented by Dr. Charles J. Thatcher, which process it is claimed will supersede, because of its superior economy, the chemical process heretofore used. The company organized about a year ago was financed by offering its 5,000 shares of stock of no par value at \$40 per share. It is understood that this financing was a complete success and that the company is beginning work with a capital of \$200,000 secured in this way.

The directors of the company comprise the following citizens of Syracuse: Carleton A. Chase, president of the First Trust & Deposit Co.; James D. Grant, vice-president and general manager of the Dyneto Electric Corporation; John Wilkinson, vice-president of the H. H. Franklin Manufacturing Company; B. Ives Cooper, Edward L. Robertson and Dr. Charles J. Thatcher.

The Modern Divining Rod

The Schermuly Polarizator Corp., 25 Broad St., New York, has acquired and will promote in the United States, the divining rod system developed by Phillip Schermuly, Frankfurt-am-Main, Germany. Felix Vogel, mining engineer, Ladenburg, Thalmann & Co., 25 Broad St., New York, is president of the corporation. Last January Mr. Schermuly demonstrated his process and apparatus on iron ore, gas and oil properties with such satisfaction to American experts, including Herman A. Holtz and John Hays Hammond, who were instrumental in bringing him over, as to warrant the acquirement and prospective development of the process in America.

Distillation and Grading of Fatty Acids

By John W. Bodman

General Manager, William Garrigue & Co.

THE distilling of fatty acids is of greater importance than many of us realize. The growth of this industry has been quite phenomenal during the last fifteen years, and I think you will find upon investigation that it has more to do with profit and loss in the refining industry than you realize.*

Fatty Acid Production

To show the importance of distillation work, I will quote a few figures from government statistics giving the total amount of fatty acids distilled during 1919 and 1920. The total production of distilled fatty acids in 1919 was 73,428,800 pounds. Divided into periods of three months, production was as follows:—

January 1st to March 31st.....	8,931,852 pounds
April 1st to June 30th.....	16,640,000 "
July 1st to September 30th.....	27,310,000 "
October 1st to December 21st....	20,541,000 "

For the year 1920 the total quantity of fatty acids distilled was 89,516,000 pounds. Divided into periods of three months, the following figures are interesting:

January 1st to March 31st.....	25,000,000 pounds
April 1st to June 30th.....	23,216,000 "
July 1st to September 30th.....	24,000,000 "
October 1st to December 25th....	15,300,000 "

The last figure cited shows the effect of drop in oil prices during the latter part of 1920.

Distillation Equipment

The accompanying illustration shows a typical Garrigue fatty acid still over a furnace of proper design. The still is about 9 ft. in diameter and has an overall height of about 24 ft. The entire still, including the dome, is constructed of special cast iron. However, beginning at the dome and carried through to the barometric condenser, the material of construction is heavy copper throughout. The reason for this con-

struction is obvious. Hot fatty acids, especially fatty acid vapors, are very corrosive to most metals. Copper and aluminum have been found to be the most economical and most satisfactory metals to withstand the corrosive action of these vapors. We have found from our own experience in construction of these plants, that on the average copper is more satisfactory than other metals.

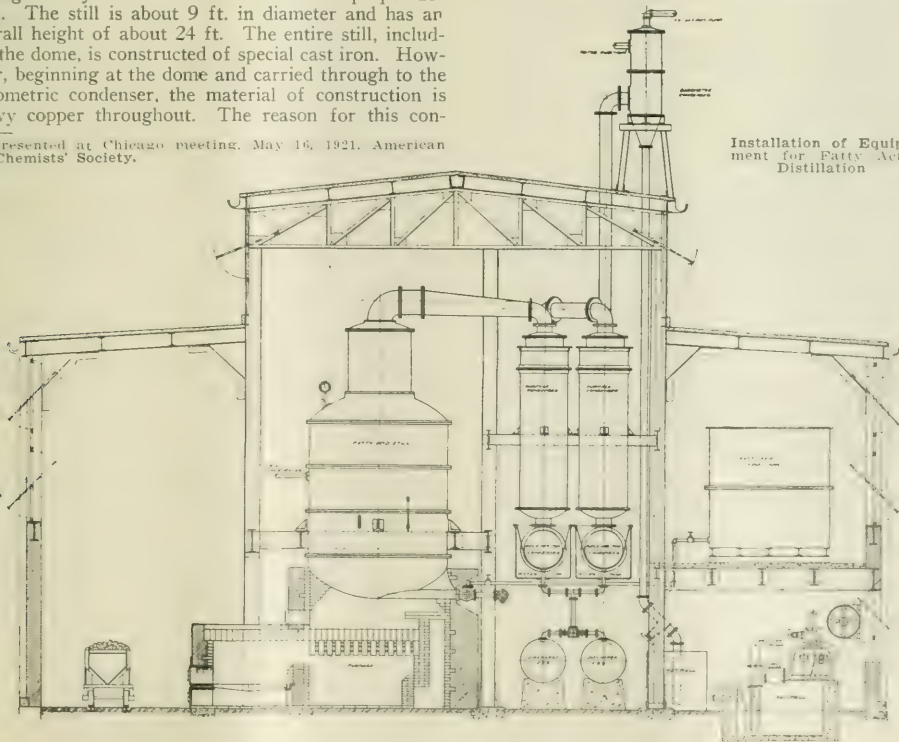
To follow the passage of vapors and condensed fatty acids in the system illustrated, a copper vapor line connects the still with the first surface condenser. Vapors condensed in the first condenser as well as uncondensed vapors pass into a receiving egg set beneath the condenser. This receiving egg is surrounded with a water jacket. These vapors pass through a second condenser where the remaining fatty acid vapors are condensed, the non-condensable vapors passing on to the barometric head. In the most modern installations rotary vacuum pumps are used for pulling dry vacuum off a counter-current barometric condenser. The general use of rotary vacuum pumps is quite recent, although it is quite true that there are a number of plants which have had these pumps in use for some time. The older types, however, were expensive, and it was only a comparatively short time ago that an inexpensive rotary vacuum pump was developed to the point where it was desirable to use it commercially.

Plant Operation

Cottonseed fatty acids such as acidulated soap stock

*Presented at Chicago meeting, May 16, 1921, American Oil Chemists' Society.

Installation of Equipment for Fatty Acid Distillation



are split or saponified to as high a degree as practical. This split, so called, averages about 94 per cent. saponification. The crude fatty acids are then washed, settled and pumped or run by gravity to drying or feed boxes where preparation for distillation is completed. To dry thoroughly the fatty acids, they are heated in the drying boxes to temperature of 220° F. and agitated with air. This treatment assures removal of all moisture from the stock.

At the beginning of operation the still is charged with about 15,000 pounds of fatty acids from the feed tanks and the still temperature raised by means of open-fire heating to about 450° F. The rate of distillation is gradually increased by the introduction of superheated steam, through a specially designed distributing system. As the temperature of the still rises, some steam will condense in the surface condensers and collect in the discharge eggs. This, of course, is blown out or pumped, as the case may be.

It is necessary that careful attention be given to control of condensing water temperatures used in the vertical copper tube condensers as it is obvious that if the amount and temperature of the cooling water are not under control that the condensing system may readily be blocked by congealed fatty acids. Similar attention must be given to temperature control of water through the barometric condenser as otherwise the tail pipe or water leg connecting the barometric condenser to the hot well may become blocked. As the fatty acids distill over, crude fatty acids are fed to the still to keep the level in the gauge glass constant. If it becomes necessary to discontinue feeding at any time because of the fatty acid level in the still becoming too high, then the steam line should be blown out with steam to prevent freezing of fatty acids in the line.

Rate of Distillation

In starting up a still on crude fatty acids and in re-distilling single-distilled fatty acids, from 1,500 to 2,000 pounds of stock should be distilled per hour. If the still does not make its rated output, it may be due to an insufficient steam supply. If, on the other hand, the rate of distillation is high and condenser temperatures are maintained properly, an excessive quantity of fatty acids may pass the condensers and go to the barometric condenser. This latter condition will be indicated by an accumulation of fatty acids in the barometric condenser hotwell. Under such circumstances, it is probable that too much steam is being turned into the still resulting in overcrowding of surface condenser capacity.

When the still is operating at a maximum capacity, the necessity for a larger quantity of cooling water can be partially offset by running the cooling water to the condensers at a somewhat lower temperature, say 90-100° F. This, however, must be done carefully and by an experienced operator, since there always is danger of freezing fatty acids locally in portions of the condensing system. Such local freezing occasionally results in choking up the entire system by closing the passageway for the gases and vapors.

The freezing of fatty acid in the condensers and serious choking up of the system are indicated usually first by the dropping of vacuum on the still. Partly solidified fatty acids will show in the sight glasses over the eggs, and the flow to the eggs will gradually cease, the white solid fatty acids showing in the glass. The operator no doubt will note the trouble long before the first condenser closes up. To open the system, the cold water should be drained from the steel water-jackets and same filled with hot water. If an open steam

line is connected into the steel packets in the erection of the plant, it is a simple matter to turn off the water and turn on steam until the water boils. The water in the steel tanks surrounding the receiving eggs should also be brought to boiling with open steam. The trouble once discovered is quickly eliminated.

The still and superheater furnaces should be fired uniformly and the feeding to the still should be uniform, as it is only in this way that uniform temperatures and even distillation can be maintained. With careful and sensible firing, about 100 pounds of coal per hour per still will be required for the still and superheater furnace combined. The quality of the distilled product is improved and the yield of good colored fatty acid increased by maintaining uniform still temperature and even distillation. When operating in this manner it will only be necessary to make slight and gradual changes in the cooling water supply.

Charges and Yields

When feeding black fatty acids to the still, from 50,000 to 125,000 pounds of stock can be fed to the still before running down to tar, this depending upon the amount of pitch obtained from the material being fed. In the case of fatty acids obtained from cottonseed foots, 50,000 to 80,000 pounds will constitute a run, whereas with fatty acids from garbage grease or low grade animal fats from which the pitch yield is relatively low, from 60,000 to 125,000 pounds of stock may run. The character of the distillate, i. e., its color and odor, will indicate when it is time to run down to tar. When the distillate becomes so dark that it cannot longer be classed or used as once-distilled stock, there is no object in continuing the run.

The yield of double-distilled fatty acids varies with the nature of the stock, the manner in which the stock is handled, and with the design and operation of the still. With fatty acids from acidulated cottonseed foots, the yield of double distilled stock is about 85 per cent. About 12 per cent. of pitch is obtained. Garbage grease fatty acids yield about 90 per cent. double-distilled stock and 6 per cent. tar. Other low grade naphtha-extracted greases will run slightly better than garbage grease, and pressed animal stock will give higher yields. The higher the split or saponification, that is, the less neutral oil left in the fatty acids, the higher the yield of distilled fatty acids. The elimination of impurities by washing improves the yield.

After the feeding of fresh stock to the still is discontinued, the still temperature gradually rises. The temperature of the superheated steam should be forced up correspondingly. After the fatty acids can no longer be seen in the gauge glass, samples should be drawn off from the tar sampler regularly to determine the consistency of the material in the still.

Residue on Distillation

The final stages of finishing pitch in the still require careful attention on the part of the operator. There have been cases where the pitch has been choked in the still and this situation may cause considerable trouble and expense to straighten out. It is not customary to use chemical control in the finishing of pitch. This stage of the operation is governed entirely by the experience of the operator.

In drawing the tar or pitch, fires are drawn from the furnaces. The valve on the vacuum line and barometric condenser is then closed and steam turned on the ejector on the tar tank. The vacuum on the still will then commence to drop. When the still vacuum is down to 5 in. or less and a vacuum of about 20 in.

has been pulled in the tar tank, the superheated steam into the still is shut off and the superheaters vented to the atmosphere. The tar line connecting the tar tank and the still is then opened. After the tar has been removed and the still has been steamed out, the tar cock on the still is closed and the still is ready for another run.

The equipment as illustrated is compact and points of control are within easy reach of the operator. The more recent changes in type of distillation equipment consist of the adoption of a rotary vacuum pump in place of old type reciprocating vacuum pumps. Improvements also have been made in the design of the steam distributing system inside the still together with design of furnace work which enables even distribution of heat over the still bottom.

I might mention at this point that some interesting work is being done on a practical scale to determine the condition in which coloring matter is carried over with fatty acid vapors from the still to condensers. Whether this coloring matter is carried over in the form of a true vapor or as mechanical entrainment has been the subject of considerable speculation. There is one point quite evident and that is that the whitest fatty acids are found in the hotwell, having passed through the barometric head. The accumulation of these light fatty acids in the hotwell indicates they are the more volatile fatty acids. We recently designed a special separator which was placed on vapor line leading from the still to the first surface condenser. As far as our experimenting has gone in this line, it indicates positively that coloring matter can be removed from fatty acid vapors mechanically. Further developments in this line are important for the reason that an increase in the yield of white stock decreases operating costs and correspondingly increases profits.

Operating Costs

The material, power and labor costs of operating a two-still plant taken from a plant recently put in operation are as follows:

20 H.P. water pump motor	} at 2½¢ per K.W.	\$1.33
50 H.P. vacuum "		
1000 lbs. steam per hour.....		.50
200 lbs. coal per hour at \$4.00 per ton.....		.40
1 fireman		.45
1 still man.....		.60
1 fireman		.45
1 helper		.40

Cost per hour.....	\$3.68
Cost per 24-hr. day.....	\$88.32

The overhead charges of this particular installation ran about as follows:

Depreciation per day on equipment at 10% per year.....	\$20.00
Stills, etc.	\$43,000.00
Additional equipment	17,000.00
	\$60,000.00
Depreciations per day on building, \$55,000 at 3% per year.....	6.00
Interest on investment:	
Building	\$55,000.00
Equipment	60,000.00
Land	8,000.00
Total	\$123,000.00 @ 6% 25.00
Insurance per day @ \$1.50 per year.....	.50
Interest per day on inventory @ \$75,000 @ 8%	15.00
Overhead per day.....	\$66.50
Total operating and overhead costs, per day, producing 24,000 pounds double distilled fatty acids.....	\$184.82
Cost per 100 pounds double distilled fatty acids.....	.65

Some of you whose accountants are using the figure of 2c per pound and charging your distillation plant with that figure may find these figures interesting. It is a fact that distilling costs only on a two-still plant, using the above figures for building and inventory, will average 65c per hundred pounds of double-distilled fatty acids. There is no reason that we know of why these costs should be more in a modern, properly constructed plant. In this plant of course, the equipment, installation and building are of the very highest class.

At the same plant the cost of fat-splitting was found to be somewhat under 30c per hundred pounds.

Comparative Costs

In order to consider possible profits in operating fatty acid distillation equipment, let us consider the following figures:

We will assume a market for cottonseed foots, basis 50% fatty acids, at \$1.00. Then, taking an acidulating expense of 30 cents per hundred and yield from acidulating of 96 pounds fatty acids per one hundred pounds of stock treated, we get the figure of \$2.50 per hundred pounds of acidulated soap stock produced. Assuming the liberal figure of \$1.25 per hundred for splitting and distillation cost, the total cost of treatment becomes \$3.75 per hundred.

There is a credit factor for pitch and glycerine to be applied, however. In the case of cottonseed fatty acids, the pitch credit may be taken on basis of 12 pounds of pitch @ ½¢ per pound, while at least 2 pounds of glycerine @ 10¢ per pound should be recovered. This gives us a total credit of 26¢ per hundred. Deducting this from \$3.75, gives us the net cost of \$3.49 for processing the fatty acids. Dividing this later figure by 83, which represents the fatty acid yield from the still, gives us the total cost of double distilled fatty acids from cottonseed foots at \$4.20.

The cost of distilling garbage grease is figured in a similar way. It so happened that on the day we received the above quotation on cottonseed foots, the market for garbage grease was given at 1½¢ per pound. Applying the same splitting and distillation cost factors against distilling garbage grease, as in the case of distilling cottonseed acidulated soap stock, you have a cost of \$2.75. A credit of 6 pounds of pitch @ ½¢ per pound and 3½ pounds glycerine @ 10¢ per pound, or a total credit of 38¢ should be given. The cost of garbage grease fatty acids ready to distill then becomes \$2.37 per hundred. Dividing this figure by 86, the fatty acid yield from the still brings cost of double-distilled fatty acids from garbage grease to \$2.76 per hundred.

You will notice from these figures that at the particular time when quotations for cottonseed foots and raw garbage grease were taken, that doubled-distilled cottonseed fatty acid could be produced for the market at \$4.20 per hundred, while double-distilled fatty acids from garbage grease could be produced for \$2.76 per hundred. This situation shows how far at times fats or greases get out of line or parity value. Of course, it is true that at other times the proposition of distilling fatty acids from cottonseed foots rather than from garbage grease is more attractive. It all depends upon market conditions.

Grading of Distilled Fatty Acids

What I say in regard to grading of distilled fatty acids is to be considered strictly as my own opinion. It is thought on the part of some who purchase distilled fatty acids that there should be a method for grading these stocks. There are absolutely no standards for grading at the present time. Assuming that

settlement of this point is of interest commercially, one of the first steps to decide is whether the color of distilled fatty acids should be judged by reflected or transmitted light. It would seem that the latter method would prove the more satisfactory, but opinion differs.

In marketing distilled fatty acids, manufacturers in general are willing to rely upon their ability to adjust their manufacturing process or the selection of stock to produce a grade of fatty acids necessary to fill a particular contract. Sales therefore are largely controlled by sample.

It may be said that color reading of 35 yellow-6 red on the Lovibond color scale read through a 1 in. column of liquid fatty acids will meet the average com-

mercial requirement. It must be borne in mind, however, in considering any grading of distilled fatty acids, that this stock is sold into a wide variety of commercial fields. From the point of view of distillers, fatty acids should be purchased on a total fatty acid basis rather than upon a saponifiable basis. It is difficult for a soap manufacturer to see the justice of this position, however, and the reason is obvious, since kettle yields are controlled by total saponifiable matter in the soap stock used. Nevertheless we cannot lose sight of the fact that distillers of fatty acids in many cases are dealing in raw stock, such as acidulated soap stock, which is sold not on a basis of total saponifiable matter, but on the basis of total fatty acids.

Sodium Acetate as a Hardening Agent in Soap-Making

By Leonard M. Liddle

NOT only has edible uses for fats and oils compelled the soap-maker to resort to inferior fat materials in which the stearin-content is low, but as well the relative value of the different glycerides, stearin (palmitin) and olein in stock commonly available, often has encouraged the separation of the former, thereby further reducing the average level of hardness of stock offered in the market.

The discovery that hardness, i. e., firm body, or increased detergent power, or both, can be imparted to soap made from soft stock, i. e., stock in which either the glyceride olein dominates, as in stock commonly liquid at ordinary temperature or in which oleic acid is the characteristic ingredient as in crude oleic acid or red oil, by the incorporation of alkali salts of acetic or lactic acid is the subject of my invention.*

In American practices soft soaps are those made from "soft" stock; hard soaps are those made from "hard" stock, "stock" being the generic term applied to the fat raw material and in both types caustic soda is the saponifying agent. Blending stock of different degrees of hardness, represented by the titer or solidifying point of their separated fatty acids, permits any degree of firmness desired in the finished soap with corresponding hydrolysis in contact with water and consequent readiness of detergent action.

My invention permits the greater use of soft stock by the addition of an extraneous hardening agent of desirable properties without the necessity of use thereof of higher-priced hard stock and without the incorporation of strongly alkaline material as soda ash and sodium silicate or of borax. No one soap fulfills efficiently every purpose, hence the division of soaps into those for the household, toilet and for manufacturers' purposes, which require respectively considerable variation of a common procedure.

Ordinary "settled" soap contains more or less free alkali, which, when the soap is intended for toilet use or for many manufacturing purposes, particularly in the silk and wool textile industries, must be neutralized. For household and general purpose soaps not only is this slight excess of alkali negligible, but it is customary to incorporate with soap varying proportions of soda ash and sodium silicate. These alkaline materials add to the detergency of the soap and also serve to harden it, but militate against its use for every purpose requiring a neutral soap.

My invention, whereby is incorporated with the soap in the crutcher, varying proportions of sodium acetate or sodium lactate, makes possible imparting to the soap

the added detergency and firmness possible by the use of the alkaline materials mentioned, but with none of the deleterious qualities inherent in their strong alkalinity.

In the manufacture of transparent soaps or in soaps made by the cold-process, the addition of sodium acetate may be made by incorporating acetic acid in amount sufficient to neutralize the excess alkali; the sodium acetate thus formed adds its virtues and permits a neutral soap. These kinds of soap require the best grades of stock, and in the case of transparent soap the addition of alcohol. The final incorporation of 1 or 2 per cent. of sodium acetate or lactate effects the desired hardening without detracting from the transparency of the soap. Sodium lactate is found to be superior to sodium acetate in promoting transparency.

A transparent soap thus may be made from a mixture of 50 per cent. of tallow, 30 per cent. of cocoanut oil and 20 per cent. of castor oil. If too much water is added during the soap-making process, the resulting soap will not harden or set, but it can be readily made to harden by the addition of a small amount of sodium acetate, and the resulting soap will still be of a transparent character and retain as usual its content of glycerin and the added alcohol.

A detergent such as soap-powder and soap in the form of flakes may contain sodium acetate with marked advantage; the softening effect of sodium resinate in all rosined soaps readily is neutralized. Liquid soap for use in shampooing and in liquid-soap dispensers can be made neutral and the hardening tendency counteracted by an increased proportion of water. The proportion of sodium acetate used, either dry or in solution, will be determined by the "softness" of the soap desired to be hardened and according to whether the salt is used as a "filler" in the manner of soda ash or sodium silicate.

An Industrial Relations Conference, authorized by Governor William C. Sproul, Pennsylvania, is being arranged by Dr. Clifford B. Connelley, Commissioner of Department of Labor and Industry, Commonwealth of Pennsylvania, to be held at Harrisburg, Pennsylvania, October 24 to 27. This conference will include the features of the Welfare and Efficiency conferences and Safety congresses of other years. The main topics to be discussed will include Industrial Waste, Industrial Co-operation, Industrial Publicity, Industrial Education, Women and Children in Industry, and the Medical Supervision of Industry.

* Letters Patent No. 1,377,843, granted May 10, 1921.

Essentials of Independence in Dyestuffs Production

By Gaston Du Bois

President, Monsanto Chemical Works

THE position of our dye manufacturing industry today is of vital import to the whole country. All other things being equal, the industry is dependent upon our efficiency from a manufacturing standpoint. During the war our dye plants were more anxious to produce the greatest possible tonnage of goods than to produce efficiently. Goods were in demand and the cost price was not as important as the ability to turn out volume. As a result of this condition, some of the basic intermediates are produced in plants which will have to be completely remodeled before we can successfully compete.

Germany in its experience of the last fifty years in coal tar chemical manufacture has stabilized the industry and has determined which methods are the most economical. Germany's plants and processes are in the hands of experienced men. All of this we yet have to build up and therefore our manufacturing methods can again be characterized as temporarily inefficient.

The interlocking of the manufacture of various chemicals and the production of by-products for which no demand exists here at the present time, but which are now utilized in Germany, give the foreign manufacturer a great advantage over the American manufacturer, and only time and development will raise us to a fairly competitive level.

Our dye and intermediate plants have been for all practical purposes closed down since October, 1920. This condition occurring in an industry undergoing a rapid evolution tends to increase the uncertainty of its position.

This uncertainty has led our dye manufacturers to realize the impossibility of determining fixed rates of duty which would permit a continuation of manufacture of those products which have been made here during the last three or four years.

This hesitation has been increased owing to the importation of foreign goods during the last six months at prices so far below our cost of manufacture as to indicate that there is something fundamentally out of line, as we are daily receiving quotations for German goods at prices—the exchange being taken into consideration—even below the pre-war cost of production in Germany. It is little wonder that, everything considered, our dye producers have come to consider a temporary regulation of imports by means of a licensing system or selective embargo as the only way by which our dye industry can be protected from the present abnormal conditions.

England in December, 1920, established an import licensing system to extend over a period of ten years, but the accumulation in English warehouses of enormous stocks of dyestuffs and the industrial crisis exist-

ing in England will prevent English manufacturers from resuming operations for many months to come.

Many American bankers and economists have been under the impression that it would be a mistake for us to prohibit the importation of any kind of chemicals or dyes on the ground that if Germany is to pay its reparation debt, Germany must be permitted to export chemicals freely and, therefore, there should be no licensing or embargo of any kind placed on American imports.

I am confident that a closer analysis of the situation would prove convincingly that in spite of the economic correctness of this view, it is in the interest of our country that the chemical industry at this time be given special consideration for the following reasons:

In dealing with the future of the German industry and the possibilities of this industry doing its share to enable Germany to pay off its reparation debt, it should be kept in mind that even if the whole American market was shut off to Germany, Germany would still have a vast field to market its chemicals and dyes in Russia, Scandinavia and other Baltic States, Austria, Hungary, the Balkan States, Asia Minor, Persia, the whole of South and Central America, Mexico, and in the

rest of the world where there is no dyestuff industry and where American dye manufacturers will be unable to market their products for years to come. It is estimated that the consumption of dyes in the United States is only about 10 per cent. of the world's consumption.

While some few dyes were made in this country before the war, it can be truly stated that as a whole the dye industry is a 'war baby,' and unlike the other industries it was organized and operated under war conditions, which explains the present inefficiency resulting from the necessity of producing goods independently of cost, goods which were required in order to keep other industries running, goods which were required for war purposes.

Since the war, the dyestuff and allied industries have had to reorganize their production methods in order to eliminate costly war methods and develop the most economical processes for operation under peace time conditions. This reorganization is one which shoe manufacturers, for instance, did not have to undergo, and while the dye manufacturers have worked with energy during the last few years, a complete reorganization of their methods and processes will require several years more before completion.

But the supreme argument, an argument which I must emphasize, is the argument of national defense. We must establish American independence in the organic chemical field if we wish to preserve American independence.



GASTON DU BOIS
President, Monsanto Chemical Works

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The Chemical Engineer
and Chemical Age



WITH tax reduction preached on one hand and on the other new devices proposed for illusory class advantage at the common cost; with stupendous debts demanding to be paid and obstacles to the power to pay imposed upon the debtors; with the sins of governmental interference in industry still inflicted upon the people in the denial of the unrestricted play of enterprise whereby the lure of gain may conscript the idle to the war of work; with work everywhere needing to be done and wants demanding satisfaction confronted with an unbending attitude that makes impossible their fulfillment; with class blindness that will not see, save at the cost of prolonged stagnation, that its highest advantage lies in the giving even more than in the getting; with unparalleled devotion to a noble cause fast receding in the perspective only to be replaced by every impulse inimical to the common good, we are impelled to submit the words of a Boston boy who won his fame in Philadelphia:

"Friends and neighbors! The taxes are indeed very heavy; and if those laid on by the Government were the only ones we had to pay, we might more easily discharge them; but we have many others, and much more grievous to some of us. We are taxed twice as much by our *Idleness*, three times as much by our *Pride*, and four times as much by our *Folly*, and from these taxes the Commissioners cannot ease, or deliver us by allowing an abatement."

THE fact that chemists are not allowed to enter the United States under contract unless they receive \$25,000 or more, or it can be shown that they can do work that no one resident here can do, directs attention to a handicap that connotes the absence in our immigration laws of the recognition of the professional status of the chemist.

That a man qualified to call himself a chemist is denied privileges accorded freely to the physician, clergyman and lawyer, with whom he is on a par from the standpoint of educational professional qualifica-

tions, in fact as regards the last two types many would quote him higher, is a commentary upon the indifference of a great and growing body of men educated in a fundamental technical profession to the status of themselves as practitioners and to the inculcation of professional standards.

THE selling price of a commodity is set by the cost of production of that portion of the total supply in any market which is produced most disadvantageously. The degree to which production costs may be reduced below this figure is a measure of the reward of efficiency in a competitive system.

Attributing responsibility for waste to management is based largely on the neglect to use facilities whereby greater efficiency may be attained. Each problem is individual and the application of approved devices and methods is determined primarily by the savings possible by their use with a steady output; which in turn is influenced by the scale of manufacturing operations.

It is the burden of production disadvantage common to all in the particular field that the individual manufacturer seeks to lessen by resorting to such improved facilities as his scale of operations will permit. That he is not backward in doing this is evidenced by the growth of American industry.

The chemical industry essentially is of the continuous type, with little of the repetitive features that characterize the machine industries, which aspect, however, becomes less pronounced in the "allied" industries. The problem of reduced production costs, therefore, is one of handling large masses in commensurate equipment with such continuity as consumption demands in a competitive market will permit.

In the effort to provide that equality of opportunity which is one of the triune essentials of democracy, the interference of government with industry has been to restrict the operation of economic law which works, if unfettered, for maximum unified production whereby each unit of material handled may bear the minimum cost.

The thirst of man for power and the temptation for its abuse make a free people fearful of its uncontrolled satisfaction; and so we pay in the penalty of seasonal production, intermittent employment, recurrent satiety and scarcity, and with the cost of infinite forms of duplicated and ill-directed effort for violation of economic law.

Waste and efficiency, as corollaries of human effort to satisfy human wants and in the process to fulfill human destiny, are aspects of a problem ever in solution.

THE significance of great problems of internal development to lower production costs demands the education of the people to their prosecution that their solution may be felt in cheaper goods. With the advent of the machine, with its increased output of goods and its increased leisure to men, power has become a cost factor of increasing importance.

A great department of chemical manufacture depends upon cheap electrical energy.

The super-power system of the North Atlantic seaboard, by correlating coal and hydraulic power for power production in great central stations strategically situated and the utilization of over 500 separate electrical plants in a system of energy distribution, means such economy in coal transportation, coal utilization, and the distribution of the power load over a large territory as will be expressed not only in the more efficient utilization and conservation of our energy resources in our foremost industrial region, but its direct reflection in cheaper goods.

FOR Germany to make her reparation payments and procure necessary food and raw materials require an export trade which will mean a corresponding displacement of products of the former allies in the open markets of the world. She will be the pace-maker in production costs of the surplus goods sold for export which largely will represent that capacity operation which permits minimum costs and fullest employment of labor in competing countries.

Discussion of domestic production economies under present conditions of prostration and uncertainty only would be to aggravate the perplexities of production management, nevertheless the American chemical and allied industries see the impending lash of compulsion. Two recourses are open, viz., the politician and the technical man.

Ordinarily entire dependence should be imposed upon the technical man, but under conditions that make futile any expectations that he can match with improved technology the unnatural favor of deranged economics and with each manufacturing nation seeking to protect itself against foreign production conditions that spell destruction and not competition, statecraft must supplement his skill in those industries whose products involve large labor costs, or wherein experience is as yet incomplete, or where the perpetuity of our institutions demands especial temporary protection.

PRODUCTION costs have become more than peculiar to an industry. They have become a national problem involving not only the responsibility of citizenship in a great co-operative society, but a scrutiny of methods in our industrial system.

If distress will teach that improvidence, unsocial activity, political abuse of public service, class aggrandizement, must be paid for, a long step will be taken in that popular education essential to the recognition of waste and of its influence on the cost of goods.

A CURIOUS phase of the evolution of the status of the American chemist is the general appreciation of the intrinsic merit of the movement looking to an economic organization of chemically trained men and the conspicuous indifference of some and the active

disapproval in devious ways of others who would suppress the expression of opinion on the subject.

The success that already has attended efforts in this direction and the constructive comment that already has been printed are ample to serve as a peg upon which to hang any condemnation that has the courage to come out in the open which is the proper arena for the struggle for survival of ideas.

No one man knows it all, nor does nor can a single coterie encompass all the virtues of service to our fellows.

INTEGRATION has its sole sanction in service. Where this end in any given direction is attained the machinery therefor should be supported, but it should not be geared to obstruct a movement from the mass that demands service in a different, definite direction.

In the process of integration among technical professional men in the chemical and allied industries this failure to serve has expressed itself in the formation of satellite organizations whose growth has demonstrated the need of the service they severally perform, *e. g.*, in the industries of fertilizers, glyceride oil, sugar, electrochemicals, leather, pulp and paper, ceramics, etc.

The organization of technical professional men in these fields could have been foretold with the same certainty as that with which astronomers indicated the location of an uncharted star. Function precedes structure; when this order is reversed artificially nature, sooner or later, will correct the perversion.

In an economic organization of men educated to serve in the chemical and allied industries and who in 5, 10, 15 years hence will be staff officers in the legion of production, we are not concerned primarily with science and its application to things as we are with men and their application to service.

CONSIDERATION of the human element in industry must not be confined to those who serve in the ranks. Industrial progress is the reaction of the personnel of the trained men of industry to the insatiable maw of human needs, and the times demand that nature be aided that their service may be of the highest degree of effectiveness to all concerned.

The formation of an economic organization of chemists is as logical a step as the formation of the American Institute of Chemical Engineers, which, under conservative guidance that works hand-in-hand with a natural process, has become of outstanding influence in chemical industry.

Upon those who deny the appropriateness and the need of similar separate organization by and on behalf of chemists, which would not trespass upon the functions of present respected and needed activity, devolves the responsibility of demonstrating the futility of a general aspiration of chemists.

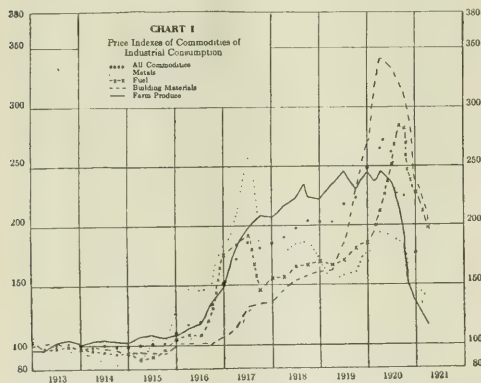
The interest of chemists everywhere in this subject makes it one that, like the tide, will not recede at the command of any chemical King Canute.

Course of Commodity Prices

THE belief, entertained by many, in the early if not present stabilization of wholesale commodity prices lends interest to the two accompanying charts, wherein are depicted the course of wholesale prices as set forth by the index numbers of the Bureau of Labor Statistics. The notable slackening in the rate of decline points to the probability of an approaching halt in the recession of average wholesale prices.

For the sake of simplicity, the index numbers from January, 1913, to April, 1921, for seven classes of commodities (taking the average of prices for each class in 1913 as the base) have been plotted on two charts. This division has been made, because of the confusion of lines which would arise if all were drawn on a single chart. The division is made between commodities of industrial and those of family consumption, although, of course, such a division is to a certain extent arbitrary. On each chart the position of the "all commodities" index is indicated.

Several interesting comparisons may be made from a study of these charts, which cover a period of extraordinary rises and falls. Three comparisons are the extent of price rises, their sequence and their duration.



Industrial Raw Materials

In Chart I the first rise shown was in metals and metal products, represented by the dotted line, beginning in the last quarter of 1915. This index reached its maximum in July, 1917, only to fall at once under government price regulation. When regulation was removed, prices for these commodities advanced a little to a peak in April, 1920, but promptly fell well below the level of the period of regulation. The principal commodities included in this index are among the most fundamental raw materials and articles manufactured therefrom.

The index, represented by the dash and cross line, of fuel and lighting, principally coal, coke, and petroleum—raw commodities of equal importance with the metals—followed the course of the metals, but did not reach such a height before price regulation. Partly as a result of the export of coal and oil, this index rose a year after the close of the war to a high peak, and has not yet returned to the level of the regulated prices.

The broken line representing building materials—lumber, brick, cement, etc.—shows a moderate rise to April, 1919, which began later and was more gradual

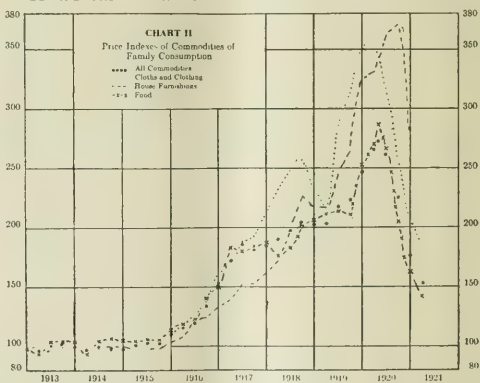
than the other advances. With the after-war haste to supply the demand for dwelling, office and factory buildings, however, the index soared to a peak in April of last year above the others in this group. The high prices effectively checked building operations, and a rapid decline took place.

It is notable that these indexes generally remained below the level of the "all commodities" index during the larger part of the period.

The only index which continued at a higher level than the "all commodities" index throughout the period of our participation in the war is that for farm produce, drawn on the chart as a solid line. Its rise, which began late in 1915, was sustained until the harvests of 1920 came upon the market. In eight months this index has fallen nearly 120 points and is now the lowest of any. Our agriculturists comprise the largest single economic group in the country, and this great decline in the prices received for their produce represents a serious decrease in the buying power of a large proportion of our population.

Household Consumption

If we turn now to Chart II we note at once that



the indexes have been practically on a level with or above the "all commodities" index since 1915. The rise of these indexes, moreover, was nearly uniform until the post-war period.

The index for cloths and clothing, represented by a dotted line, was the first of the group to rise substantially above the "all commodities" index, and it began to decline some months in advance of the others.

The index for housefurnishing goods, represented by the broken line, remained substantially below the others from 1916 to the early part of 1918. It thereafter rose to a considerably higher peak, and has not yet fallen nearly so far.

The index for food shown on the chart as a dash and cross line, has been the one most nearly comparable to the "all commodities" index. It did not reach the heights of the others and it has fallen considerably below them.

The fact that the prices of many commodities are exceptionally high in relation to the prices of other commodities indicates that we are not yet through the period of liquidation. The process of readjustment will not be complete until the relation between the levels of individual prices becomes more nearly comparable to the pre-war relation to one another.

Procedure and Products of Petroleum Refining

By C. K. Francis

Chief Chemist and Technical Superintendent of Cosden & Co.

PETROLEUM obtained from different parts of the world varies in quality, and crude oils from different wells in the same pool seldom have exactly the same characteristics; so it is, therefore, not surprising to find that similar products from petroleum, while exhibiting common general properties, may quite easily, upon close examination, be distinguished from each other. A petroleum refiner seldom attempts to make his products like those made by another refiner. The effort is always toward a product with individuality. The output of a refinery this year is not absolutely identical with that of last year.

Within the last few years the processes for the refining of petroleum have been so improved that the products from different refineries, while varying often in some particulars, have general characteristics which come within comparatively narrow ranges. The rule-of-thumb methods of former days have been replaced by operations based on scientific facts with the result that under technical supervision there is much less waste and greater output of uniform products. The scientific management of refineries and the handling of petroleum products have to rely on methods of analyses and testing; consequently there is a demand, probably the greatest need of the petroleum industry today, for uniformity in methods of testing.*

Preliminary Treatment

The process of refining petroleum often begins at the well, because crude oil usually is contaminated with water and may carry in suspension fine particles of sand which should be separated before being transported for further treatment. The processes for treating the oils on the producing property are simple. The oil is permitted to stand long enough for the water and sand to separate, since oil may not be delivered to the pipe line when it contains more than two per cent. of sand and water, commonly designated, bottom settlements or "B. S."

Some crude oils, especially those produced with gas, and water, come to the top of the well in an emulsified, or "cut" condition. This is due to the combination of mineral salts with a very small part of the oil, which, under the atomizing action of the pressure and gas, is so emulsified that ordinary washings or settlements effect no improvement. Oils of this class require special treatment which briefly consists of pumping the oil into a tank filled with steam coils in which the oil flows upward through a body of warm water, then out through an overflow pipe to a storage tank to be delivered to the pipe line. An electrolytic process is used to some extent and sometimes soap powders are employed. Recently some success in purifying cut oil has been attained by the use of centrifugal machines. This method appears to be adaptable in the field when comparatively small quantities of oil are to be treated.

Refining Procedure

The true refining operations are conducted in works equipped with special apparatus which may be comparatively simple or very complex according to the completeness of the separation and number of products made. Pipe lines transport the bulk of the crude oil from the wells to the refinery.

The most important operation conducted in a refinery is that of fractional distillation. The distillation

of petroleum is founded on a very simple process, a well-known example of which is that observed in the boiling of a tea kettle, with the difference, however, that when the vapor or steam is passed through a pipe and cooled it will collect or condense as water, the original substance; whereas, the hot vapors of petroleum, which separate when cooled according to their volatility, form different substances known as gasoline, kerosene, lubricating oils, etc.

The first operation at the refinery is to place the crude oil in a horizontal cylindrical still which may range in capacity from 150 to more than 1000 barrels.¹ The oil is heated, the hot vapors from the still passing by means of an overhead pipe, known as the vapor line, into the condenser box, which usually consists of a series of pipes covered with water. The vapors are by this device cooled and condensed to the liquid form. The liquid passes from the condenser box to the receiving house, often called the "tail-house," where it is inspected and directed to a tank known as a "run-down" tank. The stream of liquid flowing into the receiving house passes through a large trap provided with glass sides, the purpose of which is to permit the operator to observe the color or general condition of the stream, so it is appropriately designated a "sight-box" or "look-box." From the lower part of this box portions of the liquid are withdrawn from time to time for inspection.

The first or light vapors given off from the crude oil furnish crude gasoline, and then, increasing in weight, kerosene distillate, gas oil and lubricating distillate. There finally remains a residuum in the still which may be fuel oil or petroleum coke according to the degree of heating. The pipe from the look-box is manifolded into a number of pipe lines leading to different run-down tanks so that by opening and closing the proper valves the stream may be directed first to one tank and then to another according to the properties roughly determined by the still man. The usual basis of this separation is that of gravity determined in a few seconds by means of the hydrometer.

Gasoline

The first fraction from the crude oil, for convenience called crude benzine, is pumped from the run-down tank to a specially constructed tank, known as an agitator. Most agitators have a capacity of 1000 to 2000 barrels. The agitator is provided with means for mixing the liquids, and while formerly paddles and other devices were used, it is now the common practice to mix or agitate by means of compressed air.

While the charge is being agitated strong sulphuric acid is added.² The quantity of acid used may vary from 1-6 pounds per barrel of product treated according to its condition and the specific results desired. The benzine is then washed free from acid by showering water through it. Then, in order to be very certain that no acid remains, and to remove certain sulphur compounds, it is washed with dilute caustic soda.

The treated benzine is pumped to a steam still and redistilled. The vapors may be led through special towers which serve to divide them while slightly cooling and the resulting streams may be further separated in the receiving house. In this manner a series of streams are diverted from one tank to another and a

*Presented at XXIV Annual Meeting, American Society for Testing Materials, Asbury Park, N. J., June 24-24, 1921.

¹ The barrel unit in the petroleum industry is usually 42 gallons, but there is a tendency toward the use of the 55-gallon barrel. In the Mid-continent field oil, sulphuric acid of 66° Baume is used.

number of finished gasolines produced. If a gasoline free from sulphur compounds is desired it is treated in an agitator with a strong caustic soda solution which has been previously saturated with litharge. Free sulphur is then added to completely precipitate the sulphur compounds. The alkali is then removed by washing with water. Commercial gasolines may vary from 54-74° Baume in gravity and should be free from color, have a good odor, initial boiling point between 100 and 140° F. and maximum boiling point, which is often termed end point, between 350 and 460° F.

Naphtha

All of the treated benzene pumped into the steam still cannot be vaporized as gasoline because the density of the resulting liquid is too high. When the gravity falls below that of commercial gasoline a division or cut is made into the next finished product, commonly known as naphtha.

Naphtha may vary from 42-54° Baume in gravity, should have a good odor, be free from color and have a close distilling range. An ideal naphtha should begin to distill at about 200° F. and completely distill below 450° F.

Kerosene

Kerosene may be obtained partially from the kerosene fraction of the crude oil and an additional quantity from the bottoms or residue remaining in the still after the naphtha has been distilled. The purifying treatment is the same as that outlined for gasoline.

The best known kerosenes have a gravity of about 42° Baume, flash above 123° F. and do not ignite below 150° F. The color should be almost water-white. The initial boiling point should be close to 350° F. and the end point below 600° F.

Gas Oil

The fraction distilling over after the benzene and kerosene is known as gas oil. It derived its name from the fact that it was originally used in the manufacture of gas for illuminating purposes or for the enrichment of coal gas. Now, however, gas oil is used in the manufacture of synthetic gasoline and kerosene. These products are made by subjecting gas oil to a temperature of about 750° F. and a pressure above 60 lb. per sq. in. in pressure stills.

A 32-40° Baume gravity, yellow-colored gas oil usually is obtained from crude oil. This has an initial boiling point of about 400° F. and an end point (maximum) of 730° F.

Lubricating Oil

Lubricating oils are obtained from wax distillate, the fraction following the gas-oil cut. The wax distillate has the following properties: gravity, 30.0-32.0° Baume; viscosity at 100° F., 55-70; cold test, 55-80° F.

The wax distillate is cooled and the solidified wax pressed out at a low temperature under high pressure. The wax-free oil, known as "pressed distillate," is then reduced in a still to the desired viscosity lubricating stock. When reducing considerable steam is used in the distillation in order to prevent the oil from "cracking" or as still men frequently say from "burning." Heavy benzene, gas oil and light lubricating distillate are obtained as overhead products, the residue being the base for the heavy lubricating oil. The light lubricating distillate contains volatile products, which must be removed. This is performed by reducing as before with fire and steam to the viscosity specified.

The reduced lubricating stocks are further refined by treating and filtering. The oils are agitated, by means of air, with strong sulphuric acid in large agitators. It has been found that better results are ob-

tained if the acid is added in small portions instead of adding the acid all at once. A small quantity, known as "water acid," usually one pound per barrel of oil treated, is added and agitated with the oil for a short time. The agitation is then discontinued and the acid sludge permitted to settle, after which it is drawn off. Then about four pounds of new acid known as the "first body acid" is agitated with the oil. The agitation is again stopped and the acid sludge drawn off. The larger portion of the acid, "second body acid," is then added.

This quantity varies with the nature of the oil treated, but is frequently 410 pounds per barrel of oil. This is then agitated an hour or more with the oil, after which a sufficient quantity of water is added to coagulate the asphaltic material in the oil. This operation is known as "coking." The acid sludge is drawn off as quickly as possible and the asphaltic material or "coke" permitted to settle. If the proper quantity of water is not added the asphaltic material becomes finely divided or is "peppered" and is difficult to separate from the oil.

The oil which is still acid is pumped into another agitator where it is neutralized with caustic soda, a 1-5° Baume solution being used. After the acid has been neutralized the caustic soda is permitted to settle and is drawn off. The oil is then free of moisture by heating to about 120 to 140° F., and then blowing with air until the oil is bright.

During the neutralization the oil sometimes becomes emulsified or is "soaped." The emulsion is often broken by heating or sometimes by heating and agitating with a demulsifying compound. The oil should be treated in such a manner that a minimum quantity of salts are formed during the process, as these cause the finished oil to have a poor emulsion test. The acid treatment removes considerable coloring matter, but frequently through Fuller's earth until the desired color is obtained. The filtering also improves the emulsion test. After filtering, the oil is ready for the market.

Grades of Lubricating Oil

Refiners frequently manufacture two grades of lubricating oil, a light and a heavy oil. These oils generally have the following tests:

	LIGHT OIL	HEAVY OIL
Gravity	27.0 — 32.0° Baume	24.0 — 27.0° Baume
Flash	330 — 400° F.	375 — 425° F.
Fire	400 — 460° F.	460 — 500° F.
Cold test.....	10 — 30° F.	20 — 35° F.
Viscosity at 100° F.	50 — 150	200 — 400
Color (N.P.A.)....	2	3, dark red

All lubricating oils should have a fair emulsion test and a low carbon residue. Many purchasers of lubricating oils demand a light colored oil, but a good color does not necessarily signify a good lubricant.

Wax

Paraffin wax also is obtained from the wax distillate cut. The wax distillate is cooled to about 7° F. in chillers by means of ammonia or a brine solution. The solidified mass is granulated and carried forward to the presses by a helicoid conveyor. The wax is then separated from the oil by forcing the cooled mass of oil and wax through filter presses under a high pressure, approximately 350 lb. per sq. in. The crude wax remains upon the canvas filter and the oil drops into the pan below.

Slack Wax

The crude wax known as "slack wax" is removed from the press and conveyed to a tank where it is melted. The slack wax contains a large percentage of oil which must be removed. This is done by a

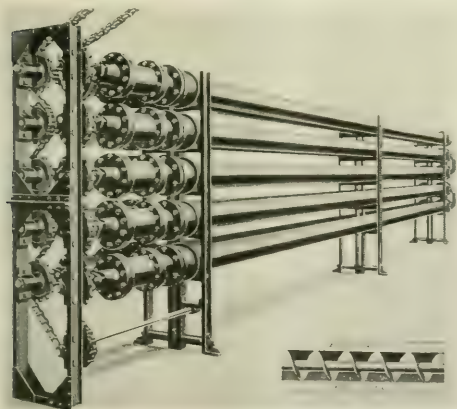
process known as sweating. The "sweaters" are large shallow pans which contain wire screens a few inches above the bottom. Sufficient water is placed in the pan to cover the screen. The melted wax is then pumped on the water and permitted to solidify slowly. When solid, the water is drawn off at the bottom of the pan, the cake of wax being supported by the screen. The temperature of the sweater room is gradually increased by means of steam in closed steam coils. The oil, known as "foots oil," first separates from the wax, followed by the low melting point or "intermediate wax."

Scale Wax

The wax from the sweater is known as "scale wax." The scale wax usually has a yellow color which is removed by treating and filtering. The scale wax is melted and treated with a few pounds of 66° Baume sulphuric acid, usually with one and three pounds in succession. The acid is drawn off and the remaining acid in the wax neutralized with 1-3° Baume caustic soda. The alkali is permitted to settle from the wax, the temperature being maintained at about 140° F. during the entire process. The melted wax is then filtered through Fuller's earth to the desired color. Wax has a specific gravity of about 0.9, a melting point of approximately 122-124° F., a 1.0 color on a 6-in. Lovibond cell and not more than 1 per cent. of oil and moisture.

Wax Tailings

After the wax distillate has been removed from the crude oil, a fraction containing considerable amorphous



Chilling Machine for Paraffin Wax Distillate

wax, known as "wax tailings," distills over. The wax tailings are not passed through the condenser coils but are permitted to pass directly from the vapor line to a small tank known as the "wax pot." They are of practically no value, being simply blended with fuel oil. Attempts have been made to use them for various purposes. They are used in waterproofing compounds and in making rubber substitutes.

Coke

Coke is the residue remaining in the still after all the volatile products have been removed. It has a high B.T.U. value, sometimes as high as 15,000 B.T.U. It is used in making battery and arc-light carbon and in metallurgical operations.

Fuel Oil

The composition of fuel oil varies widely. The refiner who runs a skimming plant simply removes the gasoline, kerosene and gas oil from the crude oil and

sells the remainder as fuel oil. At times when there is little demand for gas oil, he does not even take the trouble to remove this. Other refiners remove the wax



Paraffin Wax Press

distillate. The large refiner also sells as fuel oil the bottoms left in the pressure stills after the gas oil has been cracked.

The gravity of fuel oil ranges from 14-30° Baume depending upon the number of products removed from the crude. B.T.U. value varies from 18,000-19,000. The sulphur content of Mid-continent fuel oils is rarely more than 0.5 per cent. A high grade fuel oil should not contain more than a trace of sand, carbon and water.

Cylinder Stock

Crude oil which has a bright green color is distilled with considerable steam in order that a heavy oil may be obtained after the gas oil and a portion of the wax distillate have been removed. This product is known as cylinder stock. Cylinder stock should have a high flash and fire test; the color should be green to red, not brown nor black. If a brighter color is desired, the oil is treated and filtered.

Cylinder stocks from Mid-continent crude oils usually have the following tests:

Gravity	20.0-23.0° Baume
Flash	500-600° F.
Fire	575-700° F.
Cold Test	40-70° F.
Viscosity at 212° F.	130-250
Color	Green

Petrolatum

Petrolatum is obtained by diluting cylinder stock with naphtha and then chilling or "cold settling" until the amorphous wax or petrolatum separates. The liquid is drawn off, after which the naphtha, remaining in the petrolatum, is distilled off in a steam still. The residue is usually dark in color. If a brighter color is desired, a naphtha solution of the petrolatum is treated and filtered before steam stilling.

Methods have been developed for separating petrolatum from the cold cylinder stock by means of centrifugal force: the machines operating often around 15,000 r.p.m., handling the cold oil, the entire apparatus being in a room maintained at a low temperature. The machines used for this purpose are operated on the same principle as those employed for separating cream from whole milk.

Asphalt

The black tar-like residue remaining in the still when an asphaltic base crude oil is distilled, is known as asphalt. If the crude oil is distilled with steam, the asphalt is frequently hard and brittle. If, during the distillation, the residue is blown with air, the asphalt is softer and more ductile.

Asphalt should be free from coke and yield not more than a trace of ash. In order that these impurities may be detected, purchasers of asphalt frequently specify that it shall be 99 per cent. soluble in carbon disulphide.

The University and Research

By Dr. Vernon Kellogg

Permanent Secretary, National Research Council

THE main sources of research in America have been, and must continue to be, the universities. We have a few first class special research institutes and we have a good many laboratories of industrial research and development. There are more of these than is popularly known; five hundred, perhaps, counting many small ones. But their work is directed more towards the attack of specific problems of development in the special industries which support them, and less towards the fundamental science that underlies these industries.*

In some of the larger of these industrial research laboratories, however, able investigators are at work and fundamental research of a high quality is carried on. But in all of the few special institutes and the many industrial laboratories taken together the research output is much less than that which comes from the universities. Moreover, of one thing, very important to the maintenance of research, these special institutes and industrial laboratories do almost nothing at all. That is the development and training of new research workers. This is done almost exclusively in the universities and colleges. Anything, therefore, which lessens the interest and activities of the universities in research, and hence reduces their actual output of research and research workers, is a menace to our national strength and well-being. For this strength and well-being depend, in a very large measure, on scientific research and discovery.

The conspicuous role played by science in the war from its very beginning, and the pressing necessity for solving serious war problems involving scientific investigation, brought very vividly to the attention of the world the advantage to a nation of large scientific resources, both in equipment and personnel, and of being able to mobilize quickly and effectively these resources to aid in meeting the great emergencies created by war conditions.

German Reliance on Research

At the beginning of the war Germany revealed herself far better prepared than any other country to take swift advantage of her scientific resources. In my interesting conversations in 1915 and 1916 with officers of the German General Staff at their great headquarters in occupied France, where I had to reside for some months as chief representative for occupied France of Mr. Hoover's relief organization, I was much impressed by the reliance placed by these officers on the help they were receiving and could always expect to receive from Germany's scientific men. When things were going badly on the West Front they would say: "Well, just wait; our scientific men will give us something new. They are all organized; they are all working; they will have something new soon to make your eyes stick out."

It is familiar history now that Germany's science, brought to the aid of her armies and navy, did repeatedly make our eyes stick out, and it was necessary before the war could be won to meet German's science with English and French and Italian and American science. We and the Allies had to organize science, too, and with a haste made desperate by necessity, it was done.

Organization of Science

Out of the revelations and experiences of the war came a great recognition and stimulus to the development of science which have resulted in the setting up by America, and several other nations, of new scientific organizations for the encouragement and support of scientific research and its applications by methods giving special attention to co-operation and co-ordinated work. Such methods involve an attempt to introduce a certain degree of organization into scientific investigation beyond that heretofore usually attempted.

The phrase, "organization of science," produces an unfavorable reaction from some scientific—and some non-scientific—men. It seems to suggest to them attempts to control scientific genius, to dominate scientific endeavor. They say that genius cannot be organized, that scientific research must, like creative art, be left absolutely free from restraint. They ask if Galileo and Darwin and Einstein could have done greater things, or even the great things they have done, if they had been "organized." The implied answer is an emphatic No. And it may be accepted as the correct answer. But the question implies something that is not necessarily implied in the phrase "organization of science."

I know of no one in the National Research Council, nor do I believe there is any one in the new Department of Scientific and Industrial Research in England, or in the Bureau des Recherches in Paris, or in the National Research Council of Japan, who dreams of suggesting the advisability of organizing, or in any way interfering with, the individualistic work of scientific genius.

What is suggested as advisable, because it was proved to be possible and highly effective in our war-time efforts, is to arrange for planned concerted attack on large scientific problems, especially such problems as require numerous co-operating workers and laboratories representing, often not alone one special field nor even one major field or realm of science, but several such fields, as chemistry and physics, or chemistry and biology, or chemistry and physics and biology, or biology, geology and engineering, any one of which, and other combinations, may be involved in the solution of large scientific problems affecting the national strength and welfare.

But even the isolated, individual workers may profit by the attention and encouragement and material support that may be given them by a coherent body of scientific men bringing to bear their collective influence to ameliorate the too often difficult conditions under which the isolated scientific investigator has to work, and to develop a wider appreciation, and hence public recognition and support, of scientific research.

What is the significance to the universities of this increased attention and new impetus to research? And what is its significance to education and its methods? I suggest that this matter is so important that it requires a new and particular examination of the university and general educational situation as regards research and training for research.

*A paper read at the educational conference, May 13, 1921, held at the University of Minnesota, in connection with the inauguration of President L. H. Coffman.

Work of the National Research Council

The National Research Council has tried to become acquainted in some more exact degree than could be achieved by a perusal of college catalogues, or even an extended question and answer correspondence, with the present research situation in the colleges and universities of the country by means of a protracted series of personal visits by representatives of the council to some of these institutions. Up to the present one hundred and forty colleges and universities have been thus visited. This number includes enough institutions and institutions of enough variety to give us a fairly clear idea of the status of research and training for research in the colleges and universities of the land.

Some day we may be inclined to publish a report or discussion of this situation as based on the information derived from these friendly visits. But, for the moment, we may assume that we are all sufficiently informed in general of the state of our institutions of higher learning and the state of American higher education to warrant me in expressing certain opinions about the matter of research in the universities which your own knowledge will enable you to reject or confirm.

Conditions of University Research

I University research confronts a serious difficulty inherent in the very make-up and method of the peculiar American institution we call university. This institution is a university because it does university work. It isn't a university because it does much work that is not university work. To house under the same roofs, mix in the same laboratories, lecture and classrooms, and have sitting at the feet of the same instructors both preparatory and university students, is to produce an educational situation unique and very difficult—I should call it impossible—of successful carrying on. It is carried on, but not too successfully.

II To give most of the attention, energy and money available to this curious institution to the preparatory students in it, because there are more of them than of the advanced students, is to place in secondary position the real university interest and members of this institution.

III To give more attention and effort, as we really do, to the less capable, the uninterested, the non-attaining students than to the more capable, the interested and the attaining students, both in preparatory and university groups, is a menace to the highest usefulness of the institution if it is to exercise its true university function, which is the development of thinkers and leaders for the country. We may all be equal in our right to receive a common measure of service from the state but we are not all equal in our capacity to give service. The state, which is simply all of us, needs the benefit of the best use of our best brains, and to get it we must see that these best brains have the best of training.

IV To encourage the non-intellectual activities of the institution such as its mere expansion of size, its display, its prowess in athletics, at the expense of its truly intellectual activities and achievements, is not grateful to the eyes of believes in the great need and importance to the nation of a university system of highest standard.

All these conditions, characteristic of the present American university, as I believe all who know our universities intimately will admit, are serious difficulties in the way of the successful prosecution of research and training for research in these institutions. And this

is true even when we construe research not in the narrow sense to which a growing technical and reverential use of the word tends to limit it, but in the most generous way in which it is entitled to be used, namely, simply as a going on in the quest for knowledge from that which is now known to that which is now unknown.

These conditions to which I have just referred are not only difficulties in the way of the development and achievement of research, and specific training for research, as such, but they are difficulties in the way of the highest development of the whole intellectual atmosphere and achievement of America.

The Search for Capacity

The National Research Council has recently interested itself in an inquiry as to what is being done to discover and encourage the students of superior capacity and attainment in the colleges and universities. One of its representatives has visited, since the first of February, about fifty institutions on this quest and for the purpose of friendly suggestion. He finds a lively appreciation of the importance of the matter, but a rather faint heart about doing anything about it.

In an interesting report recently made by this visiting representative, Professor George W. Stewart, of the University of Iowa, to the Council's Division of Educational Relations, certain impressions gained from his visits were expressed as follows:

Although each ambitious teacher is anxious to develop leadership, yet, on the whole, when judged by distribution of time his emphasis in fact is laid on helping the mediocre in ability and the deficient in attainment. At first consideration, a teacher is inclined to deny the accuracy of this statement, but the visitor has found that after a brief discussion there results a fairly unanimous assent to its truth. The individual encouragement of the student of ability is one of the delights of the professor, but his class-room efforts are of necessity gauged for the average and the presence of the passing mark attracts his attention automatically and constantly to those of low standing. In other words, the routine demands a constant interest in others than the most able.

None of the colleges visited is approximating its maximum service in the encouragement of superior attainment and in the detection and development of superior ability. The methods used by any institution have been adopted fortuitously rather than as a consequence of a definite sustained study of the problem. This is to be expected, since the problem is really every one's business and concerted study and action is only given spasmodically when some one member has a single proposal that can be presented to the faculty in a form for action. This is not to be regarded as indicating a criticism of the professor but rather a weakness in our system.

Numerous colleges are utilizing mental tests in one way and another, but because of the time and hence money required, such an activity is not as widespread as it should be. Obviously such tests would be helpful in detecting superior ability. The inactivity of other colleges in this matter can be accounted for by the fact that no individual has the time to devote to it and the administration or the faculty is not adequately informed concerning mental tests.

Mental Tests

This matter of the utilization of mental tests in helping to discover the students of superior capacity and hence possibility of superior attainment, involves a wider recognition than now exists of the positive use which modern psychologists are more and more making, in their development of the applications of psychological science, of the fact that not only are there such marked differences in native intellectual capacity or ability among persons as to permit the setting up, on a basis of intelligence tests, of such categories as idiot, feeble-minded, sub-normal, average normal, superior and genius, but that within the group

of so-called mentally normal human beings, which includes most college students, there still exist rather large differences in intellectual capacity.

We all know this to be a fact, but few of us give it sufficient attention or importance as an aid in guiding our practical activities. Now the value of the university's product is, as Terman well says, determined as much by the original quality of the raw material with which it works as it is by salary budget, instructional methods or curriculum.

In an abundantly documented recent paper, this active exponent of modern psychology reveals the high significance which an analysis of the intellectual status

of the student body of a university might have as a basis for positive action by any university determined to make the best use of its available resources for the advancement of American learning.

He shows the positive economy in money, time and mental energy that could be effected by certain radical changes in university administration, and the highly desirable results which would come from these changes in the way of enabling the university to fulfil its highest function in the advancement of learning both through teaching and research. And only by such fulfilment can the nation make the most of its potential mental capacity.

Chemists' Cooperation in Advertising

By Ismond E. Knapp

Research Chemist, Jackson Laboratory, E. I. du Pont de Nemours & Co.

DOES it seem absurd to say that the chemist can help the advertising man? Perhaps, but the truth is he can if he will, and in those instances where he has, the results are highly satisfactory.

The advertising man must get ideas that will sell goods. Those beautifully phrased generalities that helped to maintain prestige during the boom are useless in 1921. At present people want facts, demand facts, respond to facts. They want an answer to the everlasting "Why?" How can the advertising man anticipate them?

The chemist is the one man in any organization who can supply the facts. He knows more than anyone else about the actual quality of the product, the history and sources of all the materials that go into it, its ultimate analysis, its special properties, in exactly what details it differs from competitive products. If it really is the best product of its kind on the market, the chemist can tell why it is the best. If it is not the best, he can show its strong and weak points. He may not appreciate what are the best selling points, but he can supply the facts on which the advertising man can base his appeal.

Close cooperation between these two apparently unrelated departments is proving successful for many progressive manufacturers. For example, several petroleum companies are emphasizing chemical tests in advertising their gasolines and lubricating oils. A prominent paper company accents quality, and shows how that quality is maintained and improved through the work of their research laboratory. A well-known yeast company is educating the public to a speaking acquaintance with vitamins and is showing the value of yeast as a food. A leading zinc company puts out educational advertising showing the wide range of products that the chemist can make from the one basic material—zinc. The advertising of certain paints, asbestos products, shaving creams, and many food products, also shows evidence of chemists' cooperation.

Most progressive manufacturers have come to see need of chemists in their plants, but the general public is not yet sold on this chemist idea. The man in the street has a natural, inborn curiosity as to the "reason-why," but he needs to be shown that, through the research work of chemists and other scientists, the ultimate "reason-why" is being discovered. Especially noteworthy in this connection is the recent series of advertisements for Mazda Research Service. The far-sighted advertising manager can, with the active co-operation of a good chemist, develop the confidence of the public in his product by presenting facts as to how

the chemist is standardizing that product, how he is improving the process of manufacturing it and thus lowering the cost, how he is recovering and utilizing waste materials, and how he is developing new side lines.

After all, there is a great deal of similarity between the chemist and the advertising man. The relation of the chemist to production is quite similar to that of the advertising man to sales. Each of these men thinks ahead. He is like a tugboat pulling the ship of business.

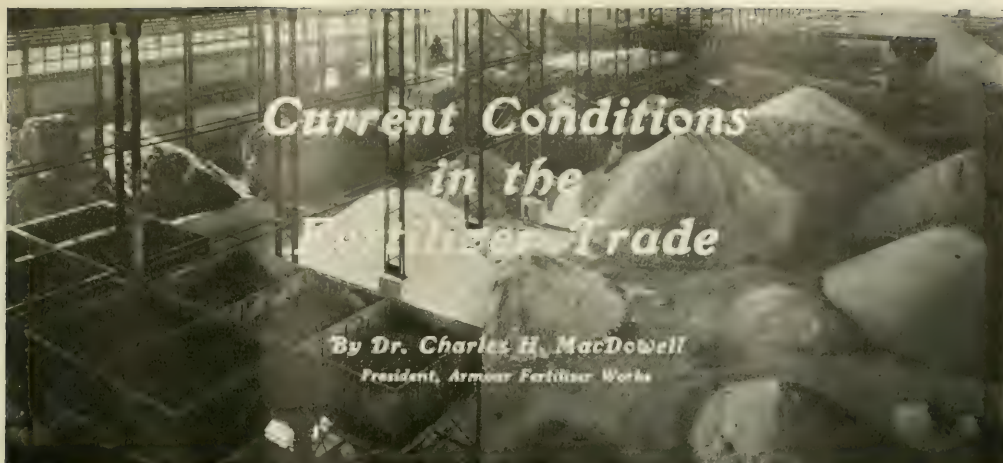
The habits of thought and lines of reasoning of the two men are similar. The chemist assembles his data from the published experimental results of other chemists and from his own research experience, just as the advertising man gathers his data from sales statistics, circulation reports, and so on. With all available data in hand, each man makes his plan. To be sure, they differ widely as to the detailed methods used in executing those plans. The average chemist knows no more about Cheltenham Bold, dealer helps, or the Ben Day process, than the average advertising man knows about burettes, autoclaves, or the gas constant. Nevertheless, there is a similarity in their mental processes. The chemist, after developing his plan in the laboratory, tries out his process on a semi-works scale before starting full-size plant operations, just as the advertising man tests the appeal of different kinds of copy on relatively small mailing lists before spending a hundred thousand dollars on a national campaign.

And what does all this mean? It means that the chemist easily can get the advertising man's point of view, understand his problems, supply him with worthwhile facts, and be of real help to him. Will he do it?

American Institute of Fertilizer Chemists

The annual meeting and election of officers of the American Institute of Fertilizer Chemists was held at Battery Park Hotel, Asheville, N. C., on June 24. Matters pertaining to the various phases of chemical work of benefit to the fertilizer trade were discussed. The following officers were elected for the ensuing year: Dr. Frank L. Parker, Charleston, S. C., president; A. G. Stillwell, New York City, vice-president; W. J. Gascoyne, Jr., Baltimore, Md., treasurer; S. W. Wiley, of Baltimore, Md. secretary.

The Hopewell Chemical Co., capital \$500,000, has been organized as a subsidiary of the Hummel-Ross Fibre Co., Hopewell, Va., to produce sodium sulphate for pulp manufacture.



Current Conditions in the Fertilizer Trade

By Dr. Charles H. MacDowell
President, Armour Fertilizer Works

Interior view of fertilizer storage building, Armour Fertilizer Works, Baltimore, Md., showing storage bins and raw materials.

IN the making of our product I take it that variations in actual costs are less than we think; but do we know what our actual costs are? If we do not, and make prices based on a hunch, and this hunch is inaccurate and below actual costs, are we not harming our industry and are we not splitting the foundations on which our prosperity depends?

There are visible elements of cost that dent our bank accounts at frequent intervals, but there are hidden and less obvious elements in cost which only show up when our plants tumble down, or when our money runs out. We are engaged in a heavy chemical industry. We produce or buy raw materials from which we make our intermediate or finished product.*

We have an acid plant. It may or it may not be properly designed to get the optimum yields; it may or may not be efficiently run, even if well-designed, to get the best results. If it is not run properly, the life of the plant is shortened materially, as against that of an equipment which has abler operation and better maintenance. The first two or three years of the operation of an acid plant are foolish years with many manufacturers because they are misled as to the cost of making acid through repair and depreciation charges much below the yearly average accruing during the life of the plant.

Depreciation

The same thing holds true throughout the entire works. A company that does not set aside a sufficient average depreciation charge to cover all items is fooling itself. These charges apply above all actual repair and renewal costs entering into plant operation. A company which does not utilize enough of the time of its accountants to estimate these charges may be saving at the spigot, but is losing at the bung hole. It may properly be called an unfair competitor. It would, therefore, seem to be the sensible thing for the fertilizer industry to fix upon a standard scale of depreciation to be used at plants, so that these elements of cost will be included. I am sure this procedure would meet with the approval of banks and insurance companies, and bring to our industry an element of stabilization beneficial to all.

Yields

There are other hidden losses in manufacturing, such

as low yields in making sulphuric acid, high insolubles in acid phosphates from uneven grinding and poor mixing, from excess iron and alumina, or improper handling of acid phosphate after it has been made. A chemical control of plant manufacture and manipulation is essential in avoiding these losses. Excessive shrinkages in high-cost materials can occur easily if a superintendent is in a hurry to get out a large tonnage. Bad weighing of bags can lose the industry hundreds of thousands of dollars a year. All of these elements should be studied and their proper significance in determining cost should be found. If the industry is to go successfully through these trying times, it must see to it that it knows its costs, that it may figure its asking price intelligently. No company can properly ask for financial support unless it knows its whereabouts and cost accounting is an essential in safe business navigation.

Inspection

From its inception the fertilizer industry has been subject to suspicion, and charges have been made against its honesty of purpose and of performance. It is easy to arouse suspicion toward any industry, and this is especially true of our industry where values can be told only by analysis and field tests—where one ton of product may only have a value of \$15 and another ton of similar appearance may be worth \$50. From this suspicion has come state inspection, and today fertilizer buyers have no fear of not getting what they purchase so far as total nitrogen, available phosphoric acid and potash are concerned.

Available Nitrogen

There exists today, however, one feature concerning which the industry properly may be criticised, and that is the availability of nitrogen, especially in lower analysis formulae. The industry is criticised by agricultural directors and educators on this point, and to my thinking properly so. One cannot but feel that a splendid advance would be made if the industry would guarantee on the bag the availability of the nitrogen contained in the goods.

Much material formerly inert is being processed and made available. In eliminating waste and in conserving values all such materials should be used where making-costs permit. Tests have shown that nitrogen soil losses are large, and as nitrogen is the highest-cost commercial plant-food, the industry gains by supplying

*From the Presidential Address of Dr. MacDowell at the 25th annual convention of the National Fertilizer Association, White Sulphur Springs, W. Va., June 22, 1921.

nitrogenous materials which meet with the approval of agricultural and chemical experts.

Multiplicity of Grades and Brands

I suppose it is instinctive for us to acquire things because they are cheap, rather than because they have value. In doing this we often pay an excessive price for what we take home. This feature enters into farm buying, and leads to purchases based on the cost per ton of fertilizer on the farm rather than of plant-food on the farm. Even in the old but not forgotten days of lower freight rates the farmer buying low-analysis fertilizers paid a high price for this weakness, but today, with high transportation charges, the cost to the farmer for such selection is excessive.

The industry complacently takes the position that it must supply the farmer with what he wants, and in many cases makes little effort to put farm plant-food-costs to the fore. One wonders if the manufacturer is not "asleep at the switch" on the point, and if he is not permitting an opening for a serious attack such as home-mixing or disproportionate acid phosphate consumption from the excessive unit-price these low-analysis goods cost the user. The industry will naturally supply the farmer with what he wants, but a good salesman, appreciating real values and the danger to the industry these low-analysis brands carry, will go in strongly for materially higher analysis goods. Our agricultural teachers tell us they are keen for more concentrated formulae.

The industry has been charged in times past with using patent medicine advertising methods and with putting out brands carrying names which make one think of "pink pills for pale people." Within the last few years there has been a tendency to call the brand by its analysis and let the name of the manufacturer stand for the quality of the mixture. Down in Dixie they call it a 10-3-3; north of the line we speak of it as a 3-10-3; and the farmer is beginning to understand what these figures mean. This is an advance.

There is still a tendency not only to sell too many brands, but to manufacture too many grades. If you will talk with your plant superintendent he will tell you this multiplicity of grades and brands is an important factor in increasing manufacturing costs. Much can be done in eliminating brands and still permit shipping all the grades needed in growing crops. This trouble is not a factory trouble. It is one the men in charge of sales have chalked up against the enterprise. We appreciate that all of this nonsense cannot be dispensed with in one year, but if those responsible for distribution will grasp the basic idea that they are also responsible for low manufacturing costs and for profits, we cannot but feel that there will be a drastic elimination of brands and formulae, and an advance in the standing of the industry.

Concealment of Costs Contributes to Wild Sales Work

In these days of specialization we are apt to eliminate some human features which have much to do with the successful conduct of organization. We assume that if a man is in charge of selling he should not know costs or profits; that a credit man's interest ceases, except for collections, when he rubber-stamps a sale; that the superintendent is only concerned in material things having to do with his daily work; that if the company has sales managers, it is none of their business what the actual profits or losses are. Even the manufacturing department often manufactures goods with little regard to the judgment of the sales division, whose task, as they see it, is to move a certain tonnage. There is divided interest, and this often

means little interest and a sacrifice of teamwork.

The fear seems to be that if a man knows what the profits are he will demand excessive compensation and "where ignorance is bliss it is folly to be wise." No thought is given to the human fact that to the man capable of success, no matter what he is paid, a part of his compensation comes from the knowledge that he is successful. No business is solid that does not possess, in a large measure, the loyalty and keen interest of those who serve it, and these qualities should not be confined by high departmental fences. One hears the remark far too frequently that he, the sales manager, does not know anything about the cost of the goods he is giving away. Unlike the horse trader, he does not know what the critter cost.

How executives can expect good work from their sales managers and other responsible representatives, unless they know costs and results, is difficult to understand. We cannot but feel that this lack of confidence in men holding responsible positions has had a good deal to do with demoralized merchandising methods. Any credit man whose interest ceases with his acceptance or non-acceptance of sales and who is not stimulated to increasing the business of the company through an instinctive desire to advance credit with proper safeguards, is only half functioning, and his company is losing through his lack of interest.

Necessity of Statistical Data

No organization should think of conducting its business without full stock-card information. It must of necessity know what it has in plant, what its shipments are, and what its stocks are after shipments. And yet, taking the fertilizer industry as a whole we possess little knowledge of its stock situation. How can we buy or sell intelligently? How can we handle our business as we should handle it without such knowledge?

We woke up last fall with a bad headache on potash. We had pains in other parts of our anatomy on sulphate of ammonia and on nitrate of soda. Today many millions of dollars of somebody's money is tied up in the United States in carrying stock which might not have been brought into the country if prompt statistical information had been available. Steps have been taken to publish in our fertilizer bulletin such figures as can be obtained from the Department of Commerce on Imports, and these should be helpful in the future.

This is all right as far as it goes, but statistics of the manufacture of sulphuric acid and acid phosphate are not available to the trade. Manufacturers go it blindly in the accumulation of materials, and we make our big bet on our ability to give away goods without endeavoring to balance production with probable demand. It is remarkable that the fertilizer industry has done so well as it has with practically no fundamental trade statistics. Little information as to exports is available until long after the fact. Only recently have we learned that we exported some thirty-two million dollars' worth of fertilizers and fertilizer materials during 1920.

Many trade associations compile statistics of the stocks and production of their members and guess at what the non-members of the particular trade are doing. The fertilizer industry has never done this. In the meat-packing trade, in grains, in the leather trade, in cotton and in cotton oil products, information is available from time to time as to the stock and manufacturing situation, and this data has been of value. In our judgment we should arrange to secure statistics concerning our basic commodities.

Secretary Hoover has placed before the manufacturing interests of the United States the value of primary trade statistics. He feels that the Department of Commerce should be a service department to American in-

dustry; that it should have no regulatory or inquisitorial powers, but that it should fight for commerce even as the Department of Agriculture and the Department of Labor contend for the betterment of the interests they represent. The Secretary is offering to fertilizer manufacturers the facilities of the Department of Commerce in the compilation and prompt publishing from month to month of vital fertilizer statistics. These figures as to individual manufacturers will be kept inviolate. Should not our industry get back of Secretary Hoover in his effort to place the Department of Commerce on the map, and should it not consider supplying the Department promptly with basic figures of production and consumption?

Muscle Shoals

The Muscle Shoals legislation failed to pass the last session of Congress. Work on the Wilson Dam is to be discontinued July 1. Propaganda from Washington is appearing in the press throughout the country. A special committee appointed by one of the farm organizations, after exceedingly rapid—perhaps *ex parte*—investigation of the subject, has recommended that the government proceed with the water power development and prepare to manufacture fertilizers for farmers. Political flypaper, sweetened with phosphoric acid and complete fertilizer promises, is being spread through the agricultural sections. Every effort will be made to pass the bill. The facts are:

I. The government already has a complete nitrogen fixation plant near Muscle Shoals, together with an enormous and efficient steam power plant all paid for. This takes care of the question of national defense.

II. There is no need from a fertilizer standpoint for the production of nitrogen as ammonium sulphate at this plant, as the American production of sulphate of ammonia is far in excess of the country's buying power. This material is now being sold at prices materially under the estimated producing cost at Muscle Shoals. If the government were in the business now it would be losing heavily.

III. The fertilizer industry has no special quarrel with the idea of the government's developing water power at public expense, although as a taxpayer it may question the propriety of making such expenditures at this time when disaster is entering the front door of agriculture and industry, largely as a result of excessive taxation and ill-considered public expenditures.

IV. A company subsidiary to the Allied Chemical & Dyestuffs Corporation has nearly completed the installation of a modified Haber process nitrogen fixation plant at Syracuse, N. Y. It is our understanding that the anticipated production cost of ammonia there is much lower than any cost which might reasonably be expected through the operation of the Muscle Shoals plant. So private enterprise is tackling the problem and providing for the future. Will it continue if the government is to be an active competitor?

V. As a matter of principle, the industry is opposed to the government manufacturing general commodities in competition with private makers and foresees large losses, both by the government and by the industry if such an unsettling, unnecessary venture is approved by the Congress.

Freight Rates

The fertilizer manufacturer has been hard hit by the advance in rates; more so than many manufacturers, as the value of his raw materials and finished product is low. Regional discriminations also prevail. Readjustments must be made as quickly as other conditions entering into the complex transportation problem are worked out and your association should, through its transportation experts, study this question, that the fertilizer case may be properly represented at the right time. At it is today, the field of distribution from a given plant is circumscribed unless prices are pitched so high harm is done the industry. You may want to consider placing the association on record as to the urgent need for lower rates.

Improved Distribution

We must study our methods of distribution and improve on them wherever possible. We should avoid expensive ways of soliciting business; dodge questionable disbursements which add to the cost of getting plant food to the farm. It would seem to be the most economical method to distribute as far as possible through dealers, as their overhead on retail sales is much less than yours if you attempt to sell and distribute through direct salaried or commission representatives during the short shipping season. The merchant does business every business day; he has a more intimate knowledge of the credit responsibility of his customers, and he can more efficiently and economically place your goods with those who need them.

You may well give thought to whether it would not be desirable to make a consumer's delivered price for your product in certain sections, paying the dealer a percentage commission for his services. This would give the user more uniform prices, and tend toward the use of higher analysis goods costing the farmer less per pound of plant food on the farm.

Liquidation Must Be Faced

It was not within the power of man to stop the movement toward lessened consumption and lower prices, without regard to costs. Those activities or industries who have not yet liquidated will have to before we make the turn toward increased demand and better times. The sooner this is realized, the better it will be for all. The world is poor and must cut its cloth carefully. In going along with such a readjustment, one can only hope to keep on top—but in the going one can at least keep one's head and heart and fare better by so doing. A panic leads to unnecessary losses and many thoughtless acts.

Self Scrutiny

During the war period and the two years following, the demand for our product was good and business was easy to secure. Our difficulty was in getting what we needed. We paid little attention to what it cost. Everything was high—salaries, materials, machinery, freight. Many of our men entered service. We employed most anybody at any price in their place. It took two people to do the work formerly done by one. We became extravagant and careless. We are now down to earth.

We must reduce our costs of doing business, not only in our own but in the public's interest. Our business is highly competitive. We work in the dark as to the tonnage we should accumulate. We have to guess more or less as to the probable demand. A large percentage of our contracts are inoperative, as we permit our travelers to contract where both they and we know that little or no business will result. We do needless traveling. We are loquacious over the long distance 'phone. We write thousands of unnecessary letters, and we do all sorts of expensive things which add to costs and which come back to plague us. In our selling we have recourse to all kinds of teasers, to heavy storage allowances, to the payment of salaries in lieu of concessions, to extravagant commissions, and to other indefensible methods.

We do not control our travelers. We let them indulge in all kinds of promises and fool talk. We delight in having them report gossip about our competitors. Above all, we do not control ourselves and run our own business, but let our suspicions lead us all over the place. It is time for us to wake up, get out of our lazy, sloppy habits, and go to work—especially with our heads. If we don't somebody else will do it for us, and that might prove embarrassing.

Improved Process of Refining Linseed Oil

By Alexander Schwarcman

Chief Chemist, Spencer Kellogg & Sons, Inc.

IN the purification of vegetable oils a common step is a treatment with caustic soda. This soda exercises a number of functions. It combines with the free fatty acids which are almost invariably present, forming a soap therewith. In addition it has the function of rendering insoluble and separable a number of albuminoid bodies always contained in the oil and of more or less unknown nature. In part these nitrogenous matters are possibly in solution in the oil, in part, probably, in suspension. Among them are probably organic bodies of the nature of what are called enzymes.

Function of Enzymes in Oil Seeds

In the oil seeds are certain albuminoid bodies called enzymes, which have for their function the breaking-up of the oil to produce free fatty acids and glycerin; something which appears to be necessary for the growth of the sprout from the seed. In the process of extracting the oil, these enzymes apparently are responsible for the free fatty acid; and unless the oil is treated in some way the formation of free fatty acids goes on, the oil becoming more acid with time.

Common Procedure of Treatment

These albuminoid bodies are also undesirable in the oil for the reason that they are impurities and tend also to cause the oil to spoil in other ways than becoming acid (rancid). Their removal is necessary in the production of a clear bright oil of good keeping qualities. Their removal particularly is necessary from linseed oil, since impure linseed oil on heating develops a "break" due to these impurities.

In the soda treatment all suspended impurities of the nature of dirt are of course carried down by the soda precipitate and the operation has a general clarifying function. Some little of the soda soap however is apt to remain dissolved or emulsified in the oil and cause trouble in subsequent use.

After the soda treatment, two general methods of procedure for removing the soda, etc., are in use in the art. One is to simply settle out the soap and separate it as "foots." The objection to this is that the "foots" invariably carry down large amounts of oil which must be afterward recovered therefrom by a separate operation and when so recovered is always of lowered grade. In simply settling out the soap and soda, the mechanical loss of oil is very great. Sometimes the settling-out is assisted by the addition of salt water or the like; the salt of the solution helping to make a separation.

Another method much used in the art in order to avoid these losses of oil is to add a little hydrochloric acid after the soda treatment and separation are complete. This breaks up the soda soaps and prevents the emulsifying action of the soda so that the aqueous liquid separates out clearly, carrying out with it most of the mechanical dirt and the albuminoids which have been separated. The fatty acids set free by the hydrochloric acid go back into solution in the oil. This method, while avoiding the great loss in volume of oil incident to the first method, has the disadvantage of not giving as good and clean a product.

The Schwarcman Process

I have found that all the elaboration of these prior methods in dealing with the soda separation are un-

necessary; and that a good and clean separation and purification of oil, without the loss of oil incident to the one method and imperfect purification due to the other method, may be secured by the simple expedient of first treating the oil with a little concentrated caustic soda solution in the cold under vigorous agitation and then diluting out or washing out with hot water.

The amount of caustic soda used is about that which would correspond to the free acids present in the oil. With most linseed oils, from 3 to 5 per cent. of a 14 to 25° Baumé caustic soda solution is required. Agitation is continued until the oil shows a break; that is, until there is a visible separation of solid matters. The alkalinized oil will not settle in the cold in any reasonable time and when settled hot the amount of neutral oil carried down in the foots is, as stated, very great.

However, if after producing the reaction with soda, the oil is raised in temperature to about 180° F. and then a small amount of hot water, say about 5 per cent., is sprayed into it, there is then a good separation. Agitation is stopped during the addition. The soda and soap solutions in the oil are diluted and the watery liquid reaching the bottom separates out cleanly and perfectly.

The water not only removes all the aqueous soda solution and soap solution from the oil, but frees the oil of dissolved soda soaps. After adding water in this way, the oil is then further washed in the same manner with further portions of hot water until it is neutral. The amount of water needed is not great. Usually five or six washings, using five or six per cent. of water each time, will suffice, except with unusually low grade oils, when more may be needed.

The watery liquid separated from the alkalinized oil is substantially a water solution of the soda soaps of the free fatty acids of the oil, carrying more or less suspended coagulated albuminoids, dirt, etc., from which the solution may be readily separated by decantation or filtration.

The solution may be used directly in soap-making, or it may be broken-up by any suitable acid, such as sulfuric acid, setting free the fatty acids as an acid oil which may be used for soap-making or other purposes. There is very little loss of neutral oil from the body of oil under treatment in the present process; usually the amount carried away is not greater than that of the fatty acids which are removed. The acid oil separated from acids rarely contains more than half its weight of neutral oil.

Dehydration and Bleaching

After the described washing the oil is of course wet, and it is necessary to remove the contained water. I effect drying by evaporation from extended surfaces of the oil in a vacuum chamber; advantageously using heat and a rather high vacuum.

This high vacuum may be produced in any of the ways known in the art, such as the employment of a barometric column with spray condenser and accessory air pump. After dehydration, the oil may next be agitated with a little fullers' earth, boneblack or other suitable decolorant or purifying agent. It is now a clear permanent neutral oil.

While I regard my method as applicable to any vegetable oil, such as cocoanut oil, cotton-seed oil, rape oil, etc., I find that it is more particularly applicable to the drying oils, such as linseed oil, nut oil, etc. It is

particularly useful in making very high grade "varnish oils" from raw linseed oil.

Varnish Oils

In making varnish oils from raw linseed oil there are a number of specific products which are made commercially.

For one such oil the requirements are that it shall be very clear or limpid, shall be neutral in character, and shall not exhibit a break (separation of solid matter) on heating to a high temperature. Such an oil is directly given by the process just described when applied to raw linseed oil.

Another high grade varnish oil desired for a number of purposes must also be clear and limpid and be likewise able to withstand heating to a high temperature but should be of a somewhat acid nature; that is, should contain free fatty acids derived from linseed oil. Such an oil may be made from the material just described by an expedient which consists in finally adding to such oil a small proportion of a linseed oil which has been treated for clarification with free sulfuric acid. The amount of such acid-treated oil to be added of course depends on the acid number desired in the product. A little of the stated "acid oil" separated from the alkali-soap deposition may be used.

Mechanical Equipment

In the accompanying diagram I have shown in elevation and in section an apparatus adapted for the purposes of this process wherein 1 indicates a treatment tank provided with the stirrers 2 suitably keyed to the shaft 3, journaled in the spiders 4 and 5 as at 6 and 7. The shaft is provided with a pulley 8 driven by belt 9 leading to a source of power.

The contents of the tank may be heated either by internal heat supplied as steam to the closed coil 10 through the inlet 11 and removed through the exit 12, or the contents of the tank may be heated by means of external heat such as steam supplied to jacket 13 through inlet 15 and removed through exit 14. The tank is provided with thermometer 16 for the purpose of ascertaining the temperature of the oil at any stage during the treatment.

The conical bottom 17 of the tank 1 is provided with a valved draw-off pipe 18 by which the contents of the tank may be delivered to the funnel 19. The use of a funnel in this connection has the advantage that in a later drawing-off of the oil, the oil may be inspected from time to time by allowing samples to run into the funnel.

The funnel is provided with valved pipe 20 leading to a second treating tank 21 for receiving aqueous soap solutions. This tank is provided with a perforated steam pipe 22 for the purpose of blowing steam into the contents and is further provided with the spray 23 in communication with a pipe 24 leading to tank 25 containing sulfuric or other acid. Pipe 24 is suitably

valved as at 26 for controlling the supply of acid to the tank.

The treating tank is provided with water spray 27 arranged to direct water in a finely divided form substantially over the entire top-surface of the oil in the tank. The spray is in communication with heated water in tank 28 by means of the valved pipes 29 and 30. The water in the tank 28 is heated to about the boiling point by means of closed steam in coil 31, steam being supplied at 33 and removed at 32.

Tank 34 for caustic alkali solution is also in communication with the spray 27 through pipes 29 and 35. When it is desired to supply alkali to the oil the valve on pipe 30 is closed and the valves on pipes 29 and 35 are opened. When it is desired to supply hot water to the spray 27 and thus to the oil, the valves on pipes 29 and 30 are opened and the valve on pipe 35 is closed.

Dehydration

For removing oil from the tank after the alkali treatment and washing, a valved pipe 36 is provided in direct communication with vacuum drier 37. This drier is provided with a jacket 38 to which steam may be admitted at 40 and exhausted at 39. The jacket may merely surround the lower half of the vacuum drier. The drier is further provided with internal stirrer 41 shown as a

spiral or screw having shaft 42 with suitable pulley 43 and driving belt 44 leading to a source of power (not shown).

This type of stirrer serves to film out the oil and assist in the drying operation. The vacuum drier is provided with the usual gage 45 and has a dome 46 with off-take pipe 47 leading to the barometric condenser 48. The provision of the dome permits removal of water from the oil in the vacuum drier at a high point away from possible foam and the like. The driers are provided with thermometer 16.

The barometric condenser is provided with vacuum gage 49, with the usual water spraying means 50 supplied through pipe 51 and with the usual water leg 52. Uncondensed gases may be removed by suitable suction means (not shown) through pipe 53. Baffle plate 59 covers the vapor entrance.

Application of Water to Treatment Tank

The water for diluting and washing should not contain acids or salts to interfere with its functioning. As it is supplied, it rains down into and through the agitated oil, combining with the aqueous suspension which the oil holds to dilute the drops thereof and produce a solution which will settle cleanly. On stopping the stirrer the solution accumulates at the bottom and may be drawn off through 18 and sent to tank 21. More hot water is now added in the same way for washing purposes, the washings drawn off and so on until the oil is neutral. These washings are also

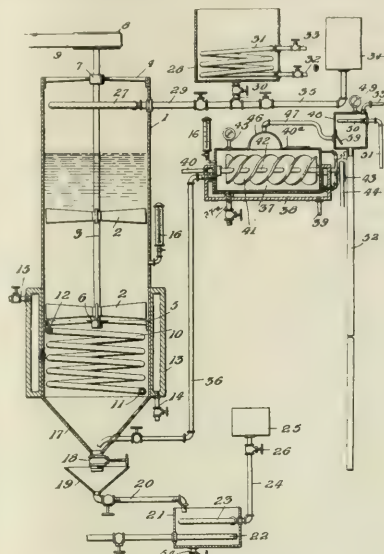


Diagram of Equipment of the Schwabman Process

sent to the tank 21. In tank 21 the liquid may be allowed to settle, and the sludge drawn off through pipe 54. The aqueous liquid may then be withdrawn and used for soap, etc.; or it may be acidified in the tank. For this purpose its temperature is raised by blowing in steam at 22 and acid is added from tank 25 by 26, 24 and 23. This results in the separation of acid oil as a floating layer.

After completion of the washing, the wet oil is drawn through pipe 36 to the vacuum apparatus 37 wherein it is agitated and caused to expose constantly changing surfaces by the slowly rotating screw 41.

The evaporation causes cooling but this is compensated for by heat from jacket 38. The evolved vapors are condensed in a barometric condenser with the production of vacuum in a well understood way.

After oil is dried which may be told by observation of the liquid in gage glass 45^a or by the vapor line 47 becoming cool, it is next treated with a little fullers' earth or the like introduced through man-hole 40^a and is withdrawn at outlet 37^a. It is now a pure varnish oil of neutral character. If acid varnish oil is desired it may receive an acid addition in the way previously described.

Japanese Chemical Industry

JAPAN is not favored with an abundance of raw materials suitable for use in the chemical industries. The most important native products are the camphor laurel, sugarcane, coal, and salt, in Taiwan (Formosa), and coal, copper ore, sulphur, and petroleum in Japan proper. Notwithstanding this initial handicap, the Japanese chemical industry has made enormous strides in recent years, and some idea of this progress may be gathered by comparing the average foreign trade in chemicals and allied products for the three years preceding the war with the trade in 1918, the last year for which complete official statistics are available; during this period chemical imports rose in value by 47 per cent. and chemical exports by 378 per cent.*

The production of sulphuric acid—long regarded as the index of a nation's industrial prosperity—was, as in the case of most chemical products, greatly stimulated by the war. In 1910 the output was about 89,000 long tons per annum, and in 1918 over six times this quantity. Further, the official estimated production for 1919, about 580,350 tons, shows that the prosperity of this industry was by no means solely due to war needs; present production is considerably in excess of home requirements, and there is a large export trade, mainly to China, the Dutch East Indies, and the Straits Settlements. About 80 per cent. of China's requirements in this acid is supplied by Japan.

Caustic Soda

The pre-war annual consumption of caustic soda—about 9,000 tons—was greatly increased during the war, and, helped by cessation of imports, the home production rose from 5,357 tons in 1914 to well over 20,000 tons in 1918. When, however, the protection afforded by war-time prices disappeared, the industry almost collapsed and output was reduced to one-half. Foreign soda began to pour into the market and the manufacturers appealed to the Government for increased import duties. It is estimated that at the present time 80 per cent. of the annual consumption of caustic soda can be produced in the country. The main obstacle to the home industry is the high cost of raw materials, notably salt and coal.

Calcium Carbide

Calcium carbide, now used in large quantities for making the fertilizer cyanamid and acetylene, has been made in Japan for many years, but it was not until 1915, when supplies from Scandinavia and the United States were cut off, that the industry was established on a large scale. During the war Japan was called upon to supply carbide to most of the Eastern nations, and the export trade rose steadily, reaching a maximum of 12,748 tons in 1918. The future of this industry in Japan is said to depend upon the marketing of a high-

quality product; most of the carbide hitherto exported has been of 55-67 per cent. purity, compared with 80-85 per cent. material marketed by foreign competitors.

Potassium Bichromate

The manufacture of potassium bichromate from native chrome-iron ore was established during the war and is now carried on by eight important firms having a total annual capacity of 1,730 tons; the official estimate of the annual home demand is 1,116 tons. Unfortunately, production costs have risen considerably and the future of the industry is held to be very doubtful unless adequate State support can be obtained. The recent history of the manufacture of potassium chlorate has been very similar, but in this case the match manufacturers are striving to secure a free market in the commodity, which they use in large quantities. The match industry also requires a plentiful supply of phosphorus and the manufacture of this substance, from native phosphoric ore of very good quality, has greatly developed since 1915; in pre-war days the raw materials for match manufacture were all imported.

Wood Distillation

An important industry which owed its inception to the war is wood distillation. At the outbreak of hostilities the rubber planters in the East saw themselves completely cut off from supplies of acetic acid (hitherto obtained from Germany), which they use for coagulating the rubber latex. Japan stepped in to fill the breach and succeeded in supplying the planters with the acid they required, although at first it was made entirely from imported calcium acetate. At the present time the Japanese manufacturers are making every effort to retain the markets they conquered during the war. The wood-distillation industry is now supplying sufficient acetone to meet the home demand, and also increasing quantities of methanol.

Ethyl alcohol was, until about twenty years ago, imported from Germany and used in the preparation of the national beverage *saké*. Heavy import duties put an end to this source of supply, and a home industry was gradually established. This spirit, so important to the fine chemical industry, is now made from the residues of the sugar factories in Taiwan. The output naturally fluctuates with the yield of sugar; in 1919 it was 3,000,000 gallons, but in 1920, owing to a poor sugar crop, some 800,000 gallons only.

Camphor

Except for about 120 tons of camphor exported annually from China and for the synthetic product made in Europe and America, Japan controls the world's supply of this important commodity. The production in Taiwan (Formosa) has, however, been declining during the past few years, and exportation has had to be

* Correspondence in London Times Trade Supplement.

strictly controlled. To this end the Japanese Monopoly Bureau has been formed to ration supplies to the United Kingdom, the United States, and France, the chief importing countries. Measures have also been taken to conserve supplies and to increase the output, and it is thought they are likely to be successful.

Twelve million camphor trees are reported to exist in Formosa, and a tree, it is said, has to be 60 years old before it comes into proper bearing. Formerly used almost exclusively for medicinal purposes, enormous quantities of camphor are now consumed in the manufacture of celluloid—also a great Japanese industry—and the world's demand, estimated at about 6,000 tons per annum, has outgrown the supply. The average annual output of refined camphor in Japan is between 4,800 and 5,400 tons.

Japan also possesses a practical monopoly of the world's supply of menthol and peppermint oil. The production of menthol crystal has decreased from 253 tons in 1917 to 118 tons in 1920, and the average price has risen in the same period from \$2.40 to \$10.32 per pound. The output of peppermint oil has fallen from 254 to 118 tons since 1917, and the average price has increased from 64 cents to \$2.44 per pound.

Although the manufacture of medicinal chemicals has also made much progress, there is still much importation, and during the past year a company with a capital of \$5,000,000 was formed to purchase drugs and other fine chemicals from Germany. Such action necessarily strikes against the development of the home industry, and it has met with considerable opposition. There is a movement in favor of importing all the needed raw materials from the United States and of levying new or increased import duties on manufactured drugs. The production of opium in Japan has made marked strides in recent years; from 91 lb. in 1910, the output increased to 842.5 lb. in 1915, to 3,213 lb. in 1917, and in 1919 it was 3,767 lb.

Dye Manufacture

The recent history of dye manufacture in Japan is in many respects very similar to that of the British and American industries. Formerly almost entirely dependent upon Germany for supplies of dyestuffs, Japan was forced to develop her own industry at an early stage of the war. The Government, realizing that the important textile industry was at stake, founded a large manufacturing company, guaranteed its dividends, and in other ways promoted the production of dyes and of dye-intermediates. It is said that the quality of the dyes made during the war left much to be desired, but the manufacturers maintain that they can produce the best grades, if not so cheaply as those made abroad. Hence the claim for a high protective tariff.

It is also reported that manufacture has been practically confined to the commoner dyes, and it is feared that recourse will have to be had to Germany for the more specialized colors. Sulphur blacks and methyl violet are produced in good quality, and large quantities are exported to China; one firm is making alizarine dyes, and there is a small production of natural indigo. In 1919 imported dyestuffs were valued at about \$7,500,000 (at normal exchange); before the war the value was about \$5,000,000, of which one-half was for synthetic indigo.

An event of far-reaching importance was the imposition last year of import duties, ranging from 20 to 35 per cent. *ad valorem*, on many imported chemicals. The chief substances affected are bromine compounds, thymol, salicylic acid and its derivatives, aspirin, diuretin, antifebrin, benzoic acid, and coal-star dyes. Ma-

terials which have escaped taxation include cinchona bark, ipecacuanha, nux vomica, ergot, and cloves. The duty on synthetic indigo has been raised to 20 per cent., and a duty has been levied on alcohol, wood spirit, and on coal-tar products other than perfumes (benzaldehyde, nitrobenzene, and nitrotoluene excepted).

Like other national industries, the Japanese chemical industry has been suffering severely from the effects of excessive speculation in the period following the Armistice and from the more recent world-wide trade depression. Many works have been closed, output has been restricted and liquidation rife, confidence disturbed, and labor troubles have added to the general unrest. It is, however, satisfactory to note that the latest reports are more encouraging, and it seems probable that, benefiting by recent experience, and relying upon her large industrious population and her technical leaders trained in the methods of science, Japan will emerge from the mists engendered by the war with power unimpaired and prospects assured.

Dyers' Formulas

The 1921 fall season Shade Card recently issued by the Textile Color Card Association of the United States is now supplemented by a new edition of Dyers' Formulas issued by the National Aniline & Chemical Co., Inc.

This booklet, which is invaluable to dyers of silk, cotton and wool, gives the recipes necessary to match the various shades of the Color Card and extends to all dye consumers the cooperation of the company's laboratories and experts in the solution of dyeing problems.

Officers of the Institute of Independent Margarine Manufacturers

The officers of the Institute of Independent Margarine Manufacturers elected at the second annual convention held at Atlantic City, N. J., on June 30 and July 1, comprise: E. P. Kelly, The Capital City Products Co., Columbus, Ohio, president; B. S. Pearsall, B. S. Pearsall Butter Co., Elgin, Ill., first vice-president; H. H. Kamsler, Armour & Co., Chicago, Ill., second vice-president; Howard Beatty, The Glidden Nut Butter Co., Chicago, Ill., recording secretary, and E. A. Stevenson, E. A. Stevenson & Co., Inc., New York, N. Y., treasurer.

The executive committee comprises, in addition to Messrs. Pearsall and Beatty: W. C. Potter, Swift & Co., Chicago, Ill.; Geo. T. Moxley, Wm. J. Moxley, Inc., Chicago, Ill.; and James A. Fagg, The Sweet-Nut Butter Co., Jamaica Plain, Mass.

The Union Dye & Chemical's plant at Kingsport, Tenn., will be sold at public auction Wednesday, August 10, under a decree issued by Chancellor H. H. Haynes, in Chancery Court at Knoxville, Tenn. The plant is now in the hands of the Equitable Trust Company of New York, trustees. The property consists of 200 acres of land and a plant which cost \$3,000,000 to build. Aside from the real assets there are included in the sale raw materials and other personality of an approximate inventory value of \$100,000. The plant was built in 1915-1916 by the Federal Dyestuff & Chemical Co., which had certain government contracts. The Federal Company failed and the Union Dye & Chemical Co. was organized to take over the contracts and plant, which in turn suspended, and in spite of unsuccessful efforts in the way of reorganization, finally succumbed. Particulars of the sale may be obtained from the receivers at Kingsport.

Energy Resources of the World and Their Utilization

By Ernest Owen

Chief Engineer, The Hoover Co., Chicago, Ill.

MECHANICAL energy is the foundation of modern civilization. The permanency as well as the expansion of the present material activity depends upon the availability of an ample source of mechanical energy. If the supply of energy is exhausted, our boasted civilization would dissolve into nothingness like the historic empires of the past.

Practically all forms of energy are derived, either directly or indirectly, from the radiant energy of the sun. The origin of the power which turns the water wheels is the sun, evaporating from the ocean the water that subsequently descends as rain or snow on high lands or plateaus; the sum total being the transference of water from a low level to a higher one. Or it may be the accumulated energy, or "bottled up sunshine" of bygone ages, preserved in the form of coal, wood, oil or gas, in which case once it is used it cannot be replaced, except, possibly, in the case of wood.

Both coal and wood, and perhaps oil, although there is a great deal of controversy regarding the latter's origin, may be regarded as derived primarily from cellulose. The green coloring matter of plants, chlorophyll, cooperating with the radiant heat from the sun, causes the combination of the CO_2 of the air and the water in the plant to produce, finally, the cellulose ($\text{C}_6\text{H}_{10}\text{O}_5$), which is the principal constituent of woody fibre. The green plants act as transformers of the radiant energy of sunlight into the potential energy of combustible substances.

Peat, lignite and coal represent different stages in the natural carbonization and distillation of the original vegetable matter, the fossil vegetation having been converted by the action of terrestrial heat and the heat generated by its own decomposition and pressure into these different forms. During the process, gases which are compounds of carbon, hydrogen and nitrogen, largely hydrocarbons and CO_2 , are expelled. Some geologists hold that these vapors have condensed in other cooler places into which they have been driven by pressure, forming oil deposits, while the uncondensable gases have impregnated the rocks and sands and have remained in place as natural gas.

Wood

Wood, the first fuel employed by man, is now of importance as a fuel only in countries where large forests abound. In certain localities of the United States cordwood is still employed as a fuel, but the steadily increasing values of even the poorest grades are rapidly prohibiting its use for steam-generating purposes. Sawdust, tanbark, shavings and other waste products of wood are burned under boilers in situations where such disposition nets the best financial return. The heat value of the fuel is, however, better used by gasification in producers and the employment of the gas in gas engines.

Timber Resources

It has been estimated that the total forest area of the United States is about 550 million acres and contains within its borders about 2,500 billion board feet of lumber. An idea of the relative magnitude of this area

can be gained by comparing it with the timber area of South America, which is given at 1,924 million acres, or that of European and Asiatic Russia, which is placed at 1,355 million acres.

A large percentage of the wood produced finds its way into the paper, pulp and lumber industries, and is, therefore, not available for fuel purposes. One-third of the timber cut in the United States each year, or about 75 million cords, is used as fuel, most of it, of course, for domestic purposes upon farms in the regions where wood is relatively abundant and cheap and coal difficult to obtain or high in price.

The manner of our forest utilization has been wasteful, one might say almost criminal. It has been shown that we are still destroying our forests as we use them, that we are taking from them each year three and one-half times as much wood as is added to them by new growth. Arthur D. Little states that on a total annual cut of 50 billion feet board measure of merchantable lumber at least 75 billion feet, or about 112,000,000 tons of wood waste are produced.

It has been proposed to convert this waste into an asset on our fuel ledger, by utilizing it as a raw material for the production of ethyl alcohol and a large number of other valuable by-products.

When freshly cut, wood contains moisture varying from 30-50 per cent. and has a heating value per pound equivalent to about 0.4 that of bituminous coal. When wood is subjected to destructive distillation a number of valuable products are obtained, the principal being charcoal, acetate of lime, methanol and tar.

Distillation

For distillation purposes, usually but two classes of wood are used, viz., the hard woods, such as oak, birch, beech, maple, and resinous woods, such as yellow pine and Douglas fir. The hard woods yield large quantities of acetic acid and methanol, while the resinous woods produce large quantities of crude oil and tar, but very little acid and alcohol. The hard wood industry is by far the more important.

The destructive distillation processes for hard woods may be divided into two distinct types: the "kiln" process and the "retort" process, the primary object in the former being the production of charcoal, while in the latter the purposes sought is not only the recovery of charcoal, but of pyroligneous acid, tar and gas. Since the substitution of coke for charcoal in iron smelting, the kiln type of plant has been discarded, as the value of the products is only about one-half of those obtained from retorts.

Ethyl Alcohol from Wood

The manufacture of ethyl alcohol from yellow pine waste has been fully demonstrated as a technical proposition. In this process the cellulose of the wood is converted by acid into sugar, the fermentation of which produces ethyl alcohol, which may be recovered in any distillery by the usual methods. The yield per cord of sawdust containing 50 per cent. water is 10 gallons.

There has been considerable discussion regarding the possibility of ethyl alcohol replacing in part gasoline as a fuel. The suitability of ethyl alcohol as a source of power in internal combustion engines has been well established. Although the calorific power of alcohol is little more than one-half that of gasoline, its

Mr. Owen's summary of the "Energy Resources of the World and Their Utilization" embraces: (1) Wood, peat, lignite, coal; (2) petroleum, natural gas, oil shale; (3) water power, tidal power, wave energy, wind power, solar energy, terrestrial heat and atomic energy. The second part will appear in the August number.

greater thermal efficiency (alcohol 40 per cent., gasoline 27 per cent.) compensates for this. Gasoline and alcohol engines of similar construction, working at a degree of compression best suited to the fuel supplied, in general, require equal volumes of gasoline and denatured alcohol respectively per brake horsepower hour. If alcohol can be produced for approximately the same price as gasoline, then we can look for extensive developments in the design and construction of alcohol internal combustion engines in the near future.

In this connection, I do not think that the production of alcohol from grain, potatoes or beets will attain much importance, as the food value of these raw materials gives them a high monetary value, making the cost of alcohol from these sources prohibitive.

Peat

Another fuel which promises to attain to considerable importance within the next few decades is peat. Though extensively used as a fuel in Europe and widely known in the United States as a potential source of heat and power, peat has been unable in most parts of the country to compete with coal, and consequently most peat operators have directed their attention to the use of peat for fertilizers.

Peat is partially decomposed and disintegrated matter, composed generally of mosses and aquatic plants, which under the combined agency of time and pressure has been converted into a spongy, brownish-black substance found in peat bogs.

The raw peat, as dug from the bog, contains as high as 90 per cent. of water, so firmly held by the fibre that pressure, centrifugal wringing, or other mechanical means are unable to eliminate any considerable percentage. However, by air-drying, with prolonged exposure to wind and sun, the moisture-content can be reduced to 20 per cent. The future of the peat industry depends primarily on the efficiency with which the moisture-saturated raw material can be converted into a product containing the necessary low moisture-content. As the production of peat for fuel has been very small in this country, we must turn to foreign countries for data regarding the development of the peat industry.

The methods of utilizing the dry product may be summarized as follows:

1. Direct burning of the air-dried peat and dried peat powder.
2. Production of peat briquettes from artificially dried powder.
3. Carbonization to produce peat-coke, gas, tar, oils, ammonia, organic acids and alcohols.
4. Gasification in producers with by-product recovery.

Of these four methods, the latter, it would seem, offers the most favorable economic solution of the peat fuel problem. In its broader aspects, this involves the construction of large power stations near the source of the fuel, the conversion of the peat into combustible gases in gas-producers, and the utilization of the gases in large gas engines to generate electric power. While this may be realized only in the distant future in the United States, to-day in Sweden, Germany and other countries of northern Europe peat actually is being used successfully in plants built at the bog, as a source of producer gas for use in internal combustion engines to generate electricity for lighting, traction and manufacturing purposes in towns miles away.

Next to coal, peat is the most widely distributed solid fuel, notwithstanding the fact that the peat bogs are confined almost exclusively to the north temperate zone. An idea of the resources and production can be had from the accompanying table. One acre of peat, one foot deep, will yield about 250 tons of air-dried peat.

Peat Deposits of the World
Peat production for fuel

Country	Area in sq. miles	Production in tons	Year
United States	11,200	20,567	1918
Great Britain	9,400	.....	.....
Ireland	4,700	7,000,000	1919
Canada	37,000	300	1916
Sweden	19,200	1,000,000	1917
Norway	2,900	100,000	1917
Denmark	400	851,000	1918
Germany	9,900	3,000,000	1917
Austria	1,500	.....	.....
Russia	38,000	10,000,000	1918
Finland	38,000	.....	.....

The deposits of peat are not uniformly distributed over our country, but occur in practically every state east of the Dakotas and north of the Carolinas to the Canadian border. It is estimated that there are nearly 12,000 square miles of peat deposit in the United States. With an average depth of 9 feet, which would represent a total of about 14,000,000,000 tons of fuel, a great and neglected resource, which, when properly and fully developed, will add to our national wealth no inconsiderable quantity of good fuel and raw material for the important arts and manufactures.

Lignite

Lignite, or brown coal is a fuel intermediate between peat and sub-bituminous coal in quality and development and comprises those coals which are either markedly woody or claylike in appearance. The percentage of water in freshly-mined lignite is large, ranging from 30-50 per cent., of which at times 20 per cent. remains when air-dried. This moisture-content affects considerably its value as a fuel, still it is used in many of the Western States and also in Europe in its raw state.

In Europe, brown coal is widely distributed through middle and north Germany and Austria and there are a few lignite deposits in Great Britain. The accompanying table will give an idea of the relative amount of lignite deposits in the different continents, although certain sub-bituminous coals are included with the lignite. This table taken from an exhaustive report upon the world's coal resources, issued by the International Geological Congress, in 1913, comprises all probable and possible reserves of coal available within 6,000 feet of the earth's surface. It is a significant fact that the two tropical continents of South American and Africa are practically destitute of coal fields of any economic importance.

Coal Resources of the World in Millions of Metric Tons

	Anthracite coals	Bituminous coals	Sub-bituminous coals & lignites	Total
Oceania	659	133,481	36,270	170,410
Asia	407,637	760,098	111,851	1,279,586
Africa	11,662	45,123	1,054	57,839
North America	21,842	2,239,683	2,811,906	5,073,431
South America	700	31,397	.....	32,097
Europe	54,346	693,162	36,682	784,190
	496,846	3,902,944	2,997,763	7,397,553

About one-third of the coal resources of the United States or 1,051,290,000 short tons, is lignite. Of this lignite 964,424,000,000 tons is in North and South Dakota and North Eastern Montana, approximately 23,000,000,000 in Texas, 7,404,300,000 in Alaska and relatively smaller quantities in several of the other Western and Southern States. The development of methods for the utilization of this low grade coal for power, light and heat will prove of much value to those communities nearest the great lignite deposits, and will result in the establishment of many industries whose

growth is dependent on abundant and cheap electric power.

Lignite is marketed mainly near the mine as a domestic fuel, but in a few places in North Dakota and Texas, it is shipped to nearby towns and used for general manufacturing purposes. Lignite may be utilized by the same four general methods mentioned in connection with the peat industry, although the detailed application of the methods will be quite different in the two cases. Because of the high moisture-content and the fact that it rapidly disintegrates in handling and when exposed to the weather, it probably will never be much used in its natural state. Therefore the treatment or carbonization of the lignite is absolutely essential to its more general use, thus breaking the coal up into valuable products, coke, gas, ammonia, oils and tars, for use in their appropriate fields.

Low Temperature Distillation

In Germany for the last half century brown-coal has been subjected to low temperature distillation with excellent results. I believe in the future all lignite, or at least that characterized by a high content of bituminous matter, will be subjected to low temperature distillation around 900° F., in order to obtain gas, light oils, ammonium sulphate, tar and coke. From the tar we can obtain paraffin and oils closely resembling those obtained from the distillation of petroleum. The coke may be utilized either in the form of briquettes or it may be converted into producer gas and employed in gas engines. The briquettes made from carbonized lignite make an excellent fuel for all practical purposes, approaching the efficiency of anthracite.

Coal

The industrial development of the 19th and 20th centuries has been closely associated with the utilization of coal as a source of power. This mineral which because of its availability, adaptability and high calorific power has become the chief fuel of the present day, is being squandered with appalling rapidity. In many minds the question is arising how to delay the day of reckoning, when man has spent the inheritance of solar energy accumulated through begone ages and when he must turn to other sources of energy.

Coals may be classified according to "rank," i. e., the degree of metamorphism they have undergone, which is indicated by the proportion of fixed carbon they contain. The U. S. Geological Survey recognizes the following ranks of coal: anthracite, semi-anthracite, semi-bituminous, bituminous, sub-bituminous and lignite.

Anthracite may be defined as a hard coal having a fuel ratio (fixed carbon divided by the volatile matter) of not more than 50-60 and not less than 10; semi-anthracite, a fuel ratio of from 6-10, and semi-bituminous a fuel ratio of 3-6. The term "bituminous coal" is applied to the group of coals having a maximum fuel ratio of about 3 hence it is a kind of fuel in which the volatile matter and the fixed carbon are nearly equal, but this criterion cannot be used without qualification for the same treatment might be made for sub-bituminous coal and lignite.

Anthracite is an almost ideal domestic fuel, but is not well adapted to steam raising, unless an absolutely smokeless fuel is desired. The cost of production of anthracite in the United States is approximately twice that of bituminous coal; it emanates from one region only, a district of heavy freights; it has no by-products to modify its cost, besides which a large portion of the available supply already is exhausted.

Bituminous coal, on the other hand, does not possess these disadvantages, and is to-day the dominant fuel dependency of American industry and commerce. In this country bituminous coal is employed generally in the raw state under steam boilers.

Methods of Coal Utilization

Scientifically, the methods of using coal may be divided into (1) direct combustion, (2) carbonization, or destructive distillation of the coal, and (3) gasification, or the conversion of the coal by reaction with air and steam into combustible gases.

For many years chemists and engineers have decried the waste from burning bituminous coal raw, and have called attention to the fact that it is more economical to separate by destructive distillation the heat or energy producing portion of the fuel from the constituents valuable as commodities, and dispose of these two groups separately to their maximum advantage.

It may be many years before coal is completely abandoned as a boiler fuel, but in the meantime great economies can be effected in its utilization in its crude state. The average steam plant, which is a small one (about 200 H. P.), uses eight times as much coal as is necessary in the largest central stations, where the profit payable to thrift is recognized. If to this initial saving of seven pounds of coal out of eight at the large electric power station are added the possible savings at the railroad and at the mine, the ratio between average practice and present best practice becomes nearly 12 to 1. Great economy can be obtained even in large plants through the more general use of fuel economizers, higher superheated steam, larger units, higher vacuum and better combustion under the boilers.

Coal in the process of mining, transportation and handling is subject to more or less disintegration. The fuel value of this disintegrated or "slack" coal can be utilized in several ways, either by pressing it into "briquettes" or by direct combustion, in specially designed furnaces, of coal-dust-air mixtures.

The briquetting industry has been established in Europe for over fifty years, but it has attracted attention in this country only during the past few years. The most favorable outlook for the development of this industry in the United States appears to be in the direction of the use of briquets in locomotives and in domestic furnaces and stoves. Owing to the cost and difficulty of manufacture and handling, they can hardly be expected to compete successfully with coal for use in the ordinary power plant.

With regard to powdered-coal plants, their number is still small, although some have been in operation in this country for 10 to 25 years. Fully 90 per cent. of the Portland cement made in the United States is burned in kilns in which powdered coal is the fuel. Powdered-coal firing has most of the advantages of gas and oil firing for steam boilers, viz., cleanliness, ease of instantaneous control, saving in labor in cleaning fires and in firing. In industrial heating its field of application is growing constantly. The use of powdered coal, however, necessitates the installation of an efficient crushing, drying, pulverizing, conveying and distributing system, the latter usually being either of the worm-screw or pneumatic type.

Methods of Coal Carbonization

There are two general methods of carbonization or coking of coal. The first involves the coking of the coal in beehive ovens, the volatile products evolved being burned in the dome of the oven to supply the heat to carry on the distillation. This process is mani-

festly wasteful, as not only are many valuable by-products lost, but part of the coke produced in the upper layers of the charge is burned. Beehive ovens, which are operated to produce high-grade coke for use in foundry cupolas and blast furnaces, are rapidly being replaced by by-product coke ovens, the total output of coke by the two methods being now about equal.

The second method, or carbonization with by-product recovery, may be sub-divided as follows: (1) High-temperature carbonization in retorts to produce coal gas. (2) High-temperature carbonization in coke ovens for the production of metallurgical coke. (3) Low temperature carbonization for the production of domestic coke.

In gas retorts the primary purpose is to produce coal gas for illuminating purposes with coke, tar and ammonia as by-products, generally no attempt being made to produce a good-quality coke. The light oils, including benzol and toluol, usually have been left in the gas to increase the candle power under that growing obsolete system of measurement. The retorts, which may be of the horizontal, inclined or vertical types, are heated from outside by combustion of part of the coke produced in the process, or of coal. The units are of smaller size than those used in coking ovens.

It is only recently that coal gas has been employed for other than illuminating purposes, having been used in England and on the continent as a fuel for motor vehicles. Because of its large bulk, coal gas is at a great disadvantage compared to gasoline, but on the other hand, being for all practical purposes a "perfect gas" and not a vapor, conduces toward clean pistons and cylinders, absence of trouble due to injector stoppage and the complete elimination of starting difficulties in cold weather. The future of gas traction depends very largely upon the development of high-pressure containers which will permit the storage of the gas in a small space.

In by-product coke ovens, coke is the principal product, gas, tar ammonia, cyanides, benzol and toluol, being recovered as by-products. The coking chambers are heated by the combustion of approximately half of the stripped gas obtained in the distillation, the temperature carried being lower than in the gas retorts.

The present systems of by-product oven construction are of two types, the one based on the horizontal flue construction of the Simon-Carves, and the other on the vertical flue of Coppée; no matter which of these two systems is followed, it will be found that the coking chamber proper usually consists of a long, narrow retort-shaped structure, built up of firebrick, in such a manner that a series of these retorts constructed side by side, form a battery of ovens. The gases on leaving the ovens pass up through the ascension pipes into a collecting main and are then passed through the coolers, scrubbers, exhausters, tar extractors and ammonia washers to the gas holder.

The discovery of important derivatives from coal tar has given rise to a number of great industries. From tar, both that obtained from coke ovens and gas retorts, is derived ammonium salts, a whole series of aromatic hydrocarbons (benzene, toluene, anthracene, naphthalene, etc.), which form the basis of the manufacture of synthetic dyes and drugs, as well as high explosives. Some progress has been made in the use of tar as a fuel, both for burning under steam boilers and in Diesel engines.

Benzol has been extensively used as a motor fuel in internal combustion engines. While benzol possesses the bad feature that its freezing point is much higher than gasoline, yet, as to thermal efficiency and power

output, it is superior to gasoline. In this connection it might be mentioned that a large number of petroleum companies in this country are marketing as gasoline a mixture of about 20 per cent. benzol and 80 per cent. gasoline. The present and even the potential supply of benzol is small compared with that of gasoline (present production equals 4 per cent. of that of gasoline) and considering the fact that it has a great number of important uses in the rubber, paint and varnish, dye-stuffs industries, etc., it can hardly be expected to supply to any great extent the deficiency caused by our decreasing petroleum reserves.

The uses of coke may be summarized as follows: (1) In the production of iron in blast furnaces and various other metallurgical processes; (2) In the production of blue and carburetted water gas; and (3) In the raising of steam.

The exit gases from the blast furnace in turn represent a high potential source of fuel, the adequate utilization of which, either by direct combustion or in gas engines, is essential in the interests of fuel economy. The development of large gas engines has been due largely to the ideal conditions existing in the steel industries, where large quantities of blast furnace gas are available, requiring only cleaning to make a perfect fuel for this type of engine.

Low Temperature Distillation

A process of carbonization, which recently has become of serious commercial consideration and which offers much promise, is the low temperature distillation of coal. This process constitutes an important means, as yet insufficiently explored by the chemist, of realizing the possibilities of coal as a source of motor and fuel oil and the production of a smokeless fuel for domestic and power purposes.

In the complete carbonization of coal it is believed that there are two stages, the first period corresponding to the formation of coke and ends when the coke has set or taken on its permanent size and shape; the second is a period of decomposition or rather distillation of the freshly set coke. Low temperature distillation is carried out in the first stage, i. e. at a temperature around 900° F., resulting in a tar which is paraffinoid in nature in distinction to high temperature (1900° F.) tar, which is rich in the aromatic hydrocarbons.

The yield of the various products from a volatile coal at these two temperatures is as follows:

	High Temp. Distillation	Low Temp. Distillation
Coke Residue (%)...	66 (1% volatile)	72 (10% volatile)
Gas (cu. ft. per ton)...	10,000	4,000
Tar (gal. per ton)...	12	24
Light Oils from Gas (gal. per ton)....	3	1½
Ammonium sulphate (lbs. per ton)....	20	10

Whether high or low temperature carbonization should be employed depends on what products are desired. For gas works, where a large volume of gas is needed, high temperature is desirable, but where oils of characteristics similar to gasoline, kerosene, fuel oil, lubricating oil and paraffin wax, are required, low temperature distillation must be adopted.

Coke produced by low temperature carbonization is softer than that produced at high temperature and usually contains 7-11 per cent. of volatile matter. The presence of this volatile matter causes the coke to burn readily, practically without flame or smoke, and to give out a great heat. Low temperature distillation of

coal furnishes an answer to the question of what we shall do when our petroleum resources are exhausted.

Gas Production

The gasification of coal and coke may be summarized as follows: (1) Gasification of coke by air-blast reactions, producing "air gas." (2) Gasification of coke and coals, previously heated, by steam-blast reactions, producing "water gas." (3) Gasification of coals by steam and air blasts, resulting in "producer gas."

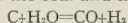
The above operations are carried on in producers, which generally consist of a steel shell lined with fire-brick, water-sealed at the bottom, with connections for an air blast. A discussion of the characteristics and relative advantages of the different types of producers, viz., up-draft suction, up-draft pressure, down-draft and double zone producers, is beyond the scope of this paper.

In the air-gas process a supply of air is passed through an incandescent fuel bed, the air being so regulated that incomplete combustion takes place,



resulting in the gradual conversion of all of the combustible matter into gas. This gas is the simplest of all the gases, made in a producer, but it has low heat value and is difficult to produce economically on a commercial basis.

The water gas process is an intermittent one in which the fuel bed is blown with air to a high state of incandescence, the air then being shut off and steam forced through the fire which dissociates the steam into its elements, oxygen and hydrogen, the former combining with the carbon of the coal and the latter liberated



During the air-blow the gas is wasted to the atmosphere, the sensible heat being sometimes recovered in part in economizer boilers that return sufficient steam to operate the plant.

Although water gas is used extensively for the production of illuminating gas, it never can play a very important part in the industrial field, owing to the large loss of energy entailed in its production. For illuminating purposes water gas, which burns with a non-luminous flame, is passed over highly heated surfaces over which a slow stream of petroleum is allowed to trickle, the latter being "cracked" by the heat into fixed gases. The enriched gas, which is really a homogenous mixture of "blue water gas" and "oil gas," is generally known as "carburetted water gas." "Mixed gas," which is used in many cities of the United States, is made from "carburetted water gas" by combining the latter with "coal gas" from the gas retorts.

The waste of energy of the coal in the intermittent process used in the production of water gas can be avoided largely by combining the two reactions in a continuous process so that a gas of uniform composition is continuously generated, the air and steam being so regulated that the heat of combustion of the carbon with the air just compensates the heat of formation of the water gas. Besides coal and coke, lignite, peat, charcoal, wood sawdust and straw have been employed in the manufacture of this gas. The product, called "producer gas," contains much free nitrogen, but the simplicity of the process causes the gas to find use on a large scale for power and heating purposes.

A gas supply for internal combustion engines must be cleaned thoroughly of both dust and tarry vapors, and also be cooled down to atmospheric temperature before delivery to the engine. Where producer gas

installations are small the returns do not warrant any attempt to utilize the constituents contained in the fuel other than the gas itself and possibly the tar. If, however, the plant be of considerable size it is possible to separate from the gas certain by-products, which are of considerable value, as ammonium sulphate.

For the past twenty years many engineers have claimed that the gas producer in combination with the gas engine would revolutionize our methods of using fuel for the production of power, because of its low fuel economies. The gas plant, however, has made slow progress as compared with the steam boiler and turbine, principally due to the fact that the recent developments in steam boiler construction have given the boiler similar advantages over the producer that the turbine possesses over the gas engine. These advantages are large capacity per unit, low first cost, simplicity and flexibility of operation, ability to carry high overloads for an extended period of time and low labor cost.

Coal Resources of the World

In the distribution of the coal resources of the world North America is in sharp contrast with South America, which is scantily endowed with coal. Though her prospects of large oil fields are encouraging and though the potential water power on the east flank of the Andes is enormous South America has smaller known reserves than that of any other continent. Africa is in an only slightly better position as regards coal reserves, although her coal production is five times that of South America.

It is significant that Europe, possessing only 17 per cent. of the world's reserves of high rank coal should produce 54 per cent. and consume 50 per cent. of the world's supply. Four major fields contribute to the European supply: (1) Great Britain; (2) the great coal fields that extend from the lower Rhine Valley, through Belgium, to Northern France; (3) the field at the junction of Poland, Germany and Austria-Hungary; and (4) the Donetz Basin in Northern Russia.

It also should be noted that Asia possesses vast and little known reserves of coal, second in the aggregate only to those of North America. The great coal fields of China may play an important part in the awakening from her economic inertia.

The United States contains a far larger quantity of high rank coal than any other country in the world. The commercial production of anthracite is virtually restricted to an area of 480 square miles in Eastern Pennsylvania. Bituminous coal is produced in 31 States, the States leading in production being Pennsylvania, West Virginia, Illinois, Ohio, Kentucky, Indiana and Alabama.

In the production of coal three countries stand out as dominating the world's coal trade, the United States, Great Britain and Germany, contributing in 1918 46, 17.5 and 18.5 per cent. respectively of the world supply, which amounted in that year to 1,468,000,000 short tons. Nearly half of the coal mined in Germany in 1918 was lignite.

Present day authorities stress the impending exhaustion of the higher grade fuels of the United States. Dr. Van H. Manning states that the life of the smokeless fuels will probably end within 150 years and the existence of the Connellsville coking coal is equally short. The available reserves of coal of the world have been computed at 7,397 billion metric tons (8,151 billion short tons), or about 5,500 times the demand for coal in 1918. The demand for coal is, however, increasing in a progressively accelerating rate.

which must be borne in mind in estimating the duration of the reserves.

It may not be in the very distant future when many of the central power stations will be combined with large by-product coke ovens and located at the mines. Influences leading to this end are the modern advances in long distance transmission of electric power, the increasing demand for and value of coal by-products for chemical purposes, the successful use of coke as a domestic and industrial fuel, the development of the gas engine and the growth of public opposition to the smoke nuisance, all of which are aspects of the conservation measures of the super power plan of the North Atlantic seaboard.

It appears that the two great competitors of modern times, the gas works and the electric central station, are approaching each other more and more and that

the near future will see a partial junction of the two power, light and heat producers, which will supplement each other to the welfare of the community and the conservation of our natural resources.

May we not conceive the power plant of the future to be one in which all the coal is treated by low temperature distillation to produce oils to supplement our rapidly failing petroleum reserves, ammonia sulphate for fertilizers and gas, tar and coke? The gas could be piped to nearby cities to supply our needs for illumination and heating, while part of the coke would be sold in the form of briquettes for domestic fuel. The greater portion of the coke, either as briquettes or combined with the residual tar and fuel oil to form a "colloidal fuel," would be burned under boilers to produce steam for the generation of power, or it would be converted into gas in producers for use in gas-engine-driven generators.

Dust Explosions—Precautions for Prevention

By the Engineering and Inspection Division, Travelers' Insurance Co.

DUST explosions in grain elevators and flour mills have been somewhat common during recent years, but explosions of this sort are by no means confined to establishments where cereals are being handled. For example, the reader will probably recall an explosion which occurred in a starch factory in the Middle West not long ago, causing forty-three deaths; and he may also remember a similar sugar-dust explosion, in consequence of which twelve persons lost their lives. Explosions of chocolate dust, spice dust, wood dust, and paper dust could also be cited. The dust need not even be organic in nature, because metallic dusts of certain kinds are notably explosive when diffused through the air in favorable proportions. We recall one explosion in which the dust in the exhaust ventilating pipes of a plant manufacturing aluminum were became ignited, apparently from a spark produced by a piece of iron wire getting wound up on the exhaust fan. In this case six girls were killed and as many more were injured.

An account of an explosion which was undoubtedly caused by the ignition of hard-rubber dust appeared in the *Travelers Standard*, October, 1920, and since that date our attention has been called to another explosive dust,—namely, that produced in connection with making fish meal. In the manufacture of fertilizers of certain kinds, dried fish are ground up into the form of a powder or "meal." The Bureau of Chemistry of the United States Department of Agriculture has tested this material and found it to be inflammable and explosive. Fish meal will ignite readily when it is blown into an open flame, and also when it is sifted through cheese-cloth upon a burning match or other open flame.

Nature of Explosion

Theoretically, any inflammable material will explode when finely divided and mixed with a sufficient quantity of air. The explosibility of a substance depends upon its composition, its fineness, and the amount of moisture present in it. If the composition is such that the material will burn, its dust may explode if fine enough and dry enough to form a cloud, and if mixed with the right amount of air.

A dust explosion often consists in a series of small explosions, producing a sound resembling the roll of thunder. The primary explosion usually occurs in a

cloud of dust occupying a comparatively small space. The percussive disturbance produced by the primary explosion throws other dust in its vicinity into a state of suspension, and this in its turn is fired, with the result that still more dust is stirred up and exploded.

Preventive Measures

To prevent the explosion of an inflammable dust, two things are evidently important:—(1) to avoid the formation of dust clouds, and (2) to eliminate all sources of ignition, such as open flames, static electric sparks, sparks from foreign matter in grinding machines, highly overheated bearings, improper electric insulation, and every other thing or condition that might start the explosive combustion of dust that is unavoidably present.

In carrying out the first of these suggestions the most obvious thing to do is to prevent the *formation* of dust, so far as this is possible. Where it is not practicable to eliminate the dust, every machine where dust is generated should be provided with an exhaust hood, having a suction pipe with a good, strong draft. By a proper outfit of this kind, the dust may be largely removed before it has an opportunity to spread about the plant. But although draft hoods may be made exceedingly effective and helpful, they do not always remove all the dust at its source, and additional precautions should therefore be taken to prevent the uncollected excess from gradually accumulating on beams and other lodging places. If this precaution is neglected, large amounts of dust may collect, here and there, in the course of time, and a sudden jar or strong draft may throw a large quantity of it into the air and create a dangerous condition.

Dust that collects on beams, side walls, and other lodging places should be faithfully and carefully removed, periodically and at intervals short enough to insure that no significant amount of it is present at any time. This work should be done when the machinery is not running, and care should be taken, while cleaning, to avoid stirring up the dust, and also to avoid scattering any of that which has been removed.

Vacuum cleaners are far safer than simple brooms or brushes, for cleaning up, and are equally effective if they are of the right type. Thorough and effective ventilation is of primary importance in rooms where dust is likely to be generated, because a large amount

of the dust will pass out with the escaping air, instead of settling on the walls and fixtures in the room.

In carrying out the second main suggestion that has been made above,—namely, eliminating all sources of ignition,—It is necessary to avoid the use of naked lights, such as candles, oil lamps, lanterns, burning gas jets of every kind, and other exposed flames and sources of high temperature. Smoking and the lighting of matches should of course be positively prohibited, under severe penalty.

The accidental production of sparks from nails, stones, grit, and other foreign material coming in contact with moving parts of the machinery should be prevented by making sure that objects and particles of this kind are removed before the stock is placed in the machines. Screening the stock, and passing it in a thin layer under strong fixed magnets, are effective methods for reducing the hazard from stones and scraps of iron.

Machines of all kinds should be closely watched to see that they do not become overheated in any part, and all bearings should be adequately lubricated to prevent needless friction.

The production of static sparks can be greatly diminished by grounding all the machinery, and by keeping the air moist in the vicinity of belts and pulleys. Where it is necessary to run belts through the air for a considerable distance, collector combs are sometimes provided, as additional protection. A comb of this kind may easily be made from a piece of bronze wire screen, by removing a few of the cross-wires so as to leave a series of projecting points. The comb is to be securely fastened under the belt and close to it, and grounded. If the comb is correctly made and installed, it will remove the high-tension electricity from the belt silently and without sparking.

The electric equipment in dusty establishments should be protected by adequate insulating devices. Incandescent lamps should be the only type used, and they should be inclosed in vapor-proof globes. Fuses and switches should be located in hallways or other places where dust is likely to occur, unless the apparatus tric motors and dynamos should not be installed in places where dust is likely to occur, unless the apparatus is of a special, explosion-proof type.

Hazard of Carbon Bisulphide

In grain elevators and other places where grain is stored, the vapor of carbon bisulphide has been used quite extensively for killing weevil and other forms of insect life. This practice is dangerous, and if it is considered necessary to use carbon bisulphide in this way, the operation should be supervised by some specially responsible person who understands the dangers thoroughly, and who has full authority to take every precaution, from the time when the exposure first begins, up to the time when the grain and the storage space and all adjoining rooms and premises have been thoroughly ventilated.

We mention this phase of the explosion problem because we believe that the combustion or explosion of carbon bisulphide vapor has been the initiating cause of some of the worst dust explosions that have occurred. The vapor does not readily mix with still air, because it is unusually heavy. It is likely to lie along the floor, or to be dammed up in the bottom of a bin or other inclosure, for a considerable time. Moreover, it takes fire at a surprisingly low temperature. In one case in which a fearful dust explosion took place not long ago, a man working in one of the offices of the plant stated that he saw a bluish flame creep across

the floor of the room he was in, and pass out into the hallway, and very shortly after that the explosion occurred. We are not prepared to prove anything about that blue flame, but the phenomena described are precisely such as might occur in connection with the use of carbon bisulphide or its vapor. A cigarette butt or a glowing match-end could easily ignite the vapor, with a fearful catastrophe as the outcome.

Canadian Compressed Gas Manufacture

The compressed gas industry of Canada as reported by the Dominion Bureau of Statistics, comprised, in 1918, 14 establishments which produced 5,484,755 cu. ft. of acetylene dissolved in acetone, valued at \$138,881; 33,880,000 cu. ft. of oxygen at \$674,693; and 2,742,632 cu. ft. of carbon dioxide worth \$221,001. By-products from the same plants were valued at \$13,696.

The cost of the materials used for manufacturing was \$89,042, while the products made had a value of \$1,048,271. The increase in value due to the process of manufacture appears to be enormous, but comparison of these data is hardly fair since, although the oxygen used is free as air, the work of abstracting it and bottling it up for commercial uses is considerable and necessitates heavy investments in machinery and equipment, on which earnings have to be made. The compressed gas industry thus differs from most other manufacturing operations in that its principal expenditures are for plant, upkeep and power.

Other firms produced a considerable quantity of chlorine and hydrogen during the year, but consumed the whole production in their own plants, the former in the manufacture of bleaching powder and liquor, the latter for the hydrogenation of oils. The production of these two gases is considered in the reports on the industries under which the firms producing them are listed, viz., "Miscellaneous Drugs and Chemicals" and "Soaps."

The selling value of the products has been shown to be \$1,048,271, so that the earnings of the industry amounted to \$506,262 above production costs. On an actual money investment of \$1,736,193, the rate of earnings is found to be slightly over 28 per cent., which may be taken as indicative of the satisfactory financial condition of this industry in Canada.

Practically all the oxygen made was produced by the liquid air process. By this means air is compressed, cooled and expanded by a continuous process until it liquefies. The nitrogen, for which there is no market, is then boiled off and discarded, leaving the oxygen to be bottled and sold. A small quantity of oxygen was also made by the electrolytic process. Oxygen is used principally in conjunction with acetylene in the oxy-acetylene blow pipe for cutting and welding metals, but it also finds considerable use in hospitals, chemical laboratories and metallurgical plants. Acetylene is produced entirely by the decomposition of calcium carbide in contact with water. Since acetylene is liable to violent decomposition when under pressures exceeding two atmospheres this gas is compressed into cylinders containing acetone, in which it dissolves. In this condition it is safe under 10 atmospheres pressure for use in such portable lighting systems as those on motorcycles and automobiles.

Carbon dioxide is used for aerated water and carbonated liquors. It is produced by passing air through incandescent coke. The carbon of the coke unites with the oxygen contained in the air to form carbon dioxide gas. This gas is then scrubbed and compressed into cylinders, in which form it is placed on the market.

Personal Items

Henry P. Talbot, professor of analytical chemistry and chairman of the faculty, has been appointed acting dean of the Massachusetts Institute of Technology.

* * *

E. B. Fuls, formerly vice-president American Tar Products Co., Chicago, Ill., has organized the Arkansas Preservative Co., St. Louis, Mo.

* * *

Glen S. Hoagland, formerly with Walter E. Lummus Co., Boston, Mass., is now with the Redpath Laboratory of the Du Pont Co. at Parlin, N. J.

* * *

A. F. Weston, formerly with Philip E. Edelman, 39 Cortlandt street, New York, is now with the De Laval Separator Co.

* * *

Dr. John H. Shrader, formerly chemical technologist, Bureau of Plant Industry, Department of Agriculture, is now in charge of the Bureau of Chemistry and Food of the Health Department, Baltimore, Md.

* * *

N. J. Thompson, formerly with the Columbia Naval Stores Co., Savannah, Ga., is now assistant manager linseed oil and turpentine department, Moore Oil Co., Cincinnati, Ohio.

* * *

George Paine, formerly of the Marden, Orth & Hastings staff, is now with Cook & Swan, Inc., 148 Front St., New York, where he will specialize in the sale of animal, fish, and vegetable oils.

* * *

Dr. E. K. Mees, director research laboratory, Eastman Kodak Co., Rochester, N. Y., had conferred upon him the degree of Doctor of Science at the seventy-first commencement of the University of Rochester.

* * *

John M. Ball, formerly chemical engineer with the Manhattan Rubber Mfg. Co., Passaic, N. J., is now a salesman of rubber chemicals with R. T. Vanderbilt Co., 50 East 42nd street, New York.

* * *

Dr. E. A. Bilhuber, formerly in charge of the color department of Chas. M. Childs & Co., Inc., Brooklyn, N. Y., is now assistant salesmanager Imperial Color Works, Glenn Falls, N. Y.

* * *

Reiman G. Erwin, chemical engineer, formerly at the St. Albans, W. Va., plant of the Roessler & Haslach Chemical Co., is now with the Celluloid Co., Newark, N. J.

* * *

Dr. John W. M. Bunker, formerly instructor in the department of sanitary engineering at Harvard University, and for the last six years director of the biological laboratories of the Digestive Ferments Company, has been appointed assistant professor of biochemistry at the Massachusetts Institute of Technology.

* * *

C. J. Esselin, Jr., 248 Boylston street, Boston, Mass., secretary Cellulose Section, American Chemical Society, announces the fourth consecutive session of this section at the fall meeting of the society in New York, September 6-10, and requests those contemplating submitting papers to send at once their titles to him.

* * *

John R. Freeman, Jr., metallurgical division, Bureau of Standards, Washington, has gone to Europe, where he will make a study of research laboratories and metal-

lurgical plants, with a view to learning the latest foreign practice in this work. He accompanied the party of engineers who are to present the John Fritz medal to Sir Robert Hadfield.

* * *

H. W. Jordan has retired from the Solvay Process Co. organization after a service of 30 years. Mr. Jordan is a '91 M. I. T. chemist who went with the company on graduation when W. L. Neill and the late John D. Pennock were the only other graduate chemists on the staff. In his long association he has been active in chemical research and in placing numerous Solvay products on a commercial basis. Latterly he has had charge of the social welfare department of the Solvay companies.

* * *

The administrative personnel of the Food Research Institute of Leland Stanford, Jr., University comprises: Dr. Carl L. Alsberg, formerly chief Bureau of Chemistry, Department of Agriculture, who will direct the Departments of Production and Distribution; Dr. Alonzo E. Taylor, formerly of the University of Pennsylvania, who will be director of the Department of Consumption, and Dr. J. S. Davis, professor of economics, Harvard University, who will have charge of banking and transportation problems.

* * *

Charles Copeland, for 18 years assistant treasurer, E. I. du Pont, de Nemours & Co., has been elected secretary and member of the board of directors. Mr. Copeland's connection with the explosive industry began several years earlier when he became assistant to J. A. Haskell, then president of the Lafin & Rand Powder Company. He served also as assistant treasurer of the Eastern Dynamite Company and of the Lake Superior Powder Company. On the consolidation of these companies with the Du Pont Company, he assumed the position which he is now leaving for his new work as secretary of the company.

* * *

P. S. Wilcox, formerly assistant manager Kodak Park Works, Eastman Kodak Co., Rochester, N. Y., has been made vice-president, general manager and a director of the Tennessee Eastman Corp., Kingsport, Tenn. The Eastman Co. in June, 1920, acquired the plant of the Kingsport Wood Reduction Co., which the government erected during the war for the production of methanol and acetone. Mr. Wilcox is a '97 Cornell man, whose initial industrial experience was with Swift & Co. at Chicago, Ill., and St. Joseph, Mo. He has been in the Eastman organization since December, 1898.

* * *

Edward G. Wilmer, who has succeeded Frank A. Seiberling as president in the financial reorganization of the Goodyear Tire & Rubber Co., Akron, Ohio, is 38 years old and a native of Milwaukee, Wis., and a law graduate of George Washington University, Washington, D. C. His first employment was in the law department of one of the Schlesinger companies called collectively the Schlesinger interests, with headquarters at Milwaukee, and rose to be the legal adviser of the late Ferdinand Schlesinger. For the past 12 years he has been associated with a group of the Schlesinger companies, holding in each the position of vice-president. These include the Steel & Tube Co. of America, the Newport Co. and the Milwaukee Coal & Gas Co.

Industrial Notes

The National Coconut Soap Co., Tacoma, Wash., utilizes the former plant of the Columbia Brewing Co. of that city as a soap factory.

* * *

The success of the Atlanta, Ga., retail paint store, of the paint department of the Southern Cotton Oil Co., has encouraged the extension of retail distribution by company stores throughout the southern states of the company's paints and supplies.

* * *

The Federal Color Laboratories, Inc., Cincinnati, O., a subsidiary of the Heekin Can Co., was a successful bidder for two contracts for the Bureau of Engraving and Printing. The corporation is increasing the capacity of its plant and expects to be ready to offer colors to the trade in a few months.

* * *

Charles Palmer, formerly director and general manager of the Diamond Match Company, and his brother, William, and son, Thomas, formerly manager and superintendent, respectively, of the Barberton plant of the Diamond Match Company, announce they will return to the match industry by organizing a match manufacturing company to be located near Akron, Ohio.

* * *

The Link-Belt Co., Chicago, Ill., has acquired the capital stock of the H. W. Caldwell & Son Co., of that city. Frank C. Caldwell has been elected a director of the former company. As a result, the Link-Belt Co. has added two new lines to its manufactures, helicoid conveyors and power transmission machinery. There will be no change of name nor of officers.

* * *

Discontinuance of operations for an indefinite period of the Detroit plant of the Solvay Process Co. is accompanied by a 15 per cent. reduction in the working force of 2,000 at the Syracuse plant, together with the curtailment of all directly non-productive activity. Production at present is running about 40 per cent. of normal. The question of the necessity of making further adjustments in wages and salaries is now being studied by the company.

* * *

Surface Combustion Co., Inc., 366 Gerard avenue, Bronx, New York, has contracted with the International Nickel Co., 67 Wall street, to install two sheet, two pair and six annealing furnaces to be fired by the Surface Combustion process in the International Nickel Co.'s new plant at Huntington, W. Va. Frank I. Ellis, 2126 Farmers' Bank Building, Pittsburgh, is the consulting engineer for this plant, acting through W. L. Wotherspoon, chief engineer of the International Nickel Co.

* * *

The best bids for the Government kelp potash plant at Summerland, Calif., was \$35,000, but certain conditions were attached which it is believed will prevent its sale to the firm making this bid. A bid of \$25,000 by M. E. Saville, of San Francisco, is believed to have more chance of being accepted. All bids have been forwarded to Dr. J. W. Turrentine at the plant for consideration and report to the Department of Agriculture. It will probably be several weeks before the final acceptance or rejection of any of the offers.

The Stearns-Roger Mfg. Co., Denver, Colo., has been awarded a contract by the Catlin Oil Shale Products Co., Elko, Nev., for new equipment for the shale plant at that place. The equipment includes two large gas producers twelve and five-tenths feet in diameter. The Catlin oil shale plant has been operating continuously for several months and is turning out refined commercial products, including paraffin wax from the wax plant. Robert M. Catlin, the principal owner of the Elko plant, is general superintendent of the Franklin Furnace, N. J., plant of the New Jersey Zinc Co.

* * *

Judge Learned Hand in the United States District Court, Tuesday, signed an order amending the decree of March 31, 1919, which required the Corn Products Refining Co. as a principal defendant in the Sherman Law Anti-Trust suit to dispose of its interests in the National Starch Co. The amended order gives the company an extension of time until October 1. The petition requesting an extension of time states that Corn Products has not yet found a buyer for its holdings in the starch company, and to dispose of it now, in face of present business conditions, would work a hardship to its stockholders.

* * *

The first unit of the Atmospheric Nitrogen Corporation's plant at Syracuse, N. Y., will be completed and put into operation August 1, with a production of 20,000 pounds of anhydrous ammonia daily. This will be the first commercial plant in the United States for the recovery of nitrogen from the air and hydrogen from water gas. New processes will be used differing from those developed in Europe.

Tentative plans call for the erection of ten units. First unit represents an investment of \$3,000,000 by Solvay Process, Semet-Solvay and General Chemical Companies. Atmospheric Nitrogen Corporation was organized in 1919 by Solvay Process Co., Semet-Solvay Co. and the General Chemical Co. The industry will when it is completed be recognized as the largest single user of the electric current in western and in central New York. This current will be delivered from Niagara Falls, 150 miles distant.

POSITION WANTED

SUPERINTENDENT with thorough knowledge of the manufacture of soaps will give his services for an interest in a soap company, now being organized, or in an established concern contemplating reorganization. Address: "TECHNIC," CHEMICAL AGE.

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WANTED—CHEMIST: One experienced in the practical manufacture of Arsphenamine. Apply, stating experience in detail, reference, and salary expected. Box 701, CHEMICAL AGE.

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FOR SALE: Centrifugal Reel, 26 inches diameter, 8 feet long. Excellent condition, good as new. Has storage bin above with conveyor in bottom to automatically feed the material to the reel. Address THE J. H. DAY CO., 90 Park Place, New York City.

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Is It the Part of Economic Wisdom to Deny to a Neighbor and a Friend the Opportunity of Growth?

By H. W. Matheson

Vice President, Canadian Electro Products Co., Ltd.

THE Canadian chemical industry has been born with much travail and pain. Because of many factors which militate against it, its growth in the ordinary course of events must be extremely slow and tedious. Those factors militating against its extension are:

(1) Abnormal cost of development; (2) limited home markets; (3) distribution over a wide area; and (4) limited export markets, due primarily to the highly protective tariff of the United States.

The capital charges involved in the establishment of any industry in Canada usually is considerably higher than that of a similar plant in the United States. This particularly is true of the chemical industry, for since this industry is so limited in extent in Canada, there are few, if any, manufacturers of chemical equipment. Consequently chemical equipment must be purchased in the United States or Great Britain, and as a matter of fact is for obvious reasons purchased almost entirely in the United States.

The heavy tariff imposed by our Government on all such equipment amounts to on the average about 20-25 per cent. of the total capital cost. It thus will be seen that considerably higher earnings must be made from the industry in order to meet the increased fixed charges. This is the first and perhaps one of the most serious handicaps placed on the Canadian chemical industry.

Canada with a population of some 9,000,000 people utilizes, in general, the major number of all those chemicals which are now manufactured, but to the extent of not more than 8 per cent. of the consumption

in the United States. The problem confronting the Canadian manufacturer of chemicals, therefore, is to select from these various chemicals, those which can

be manufactured economically to the extent stated, bearing in mind the fact that the distribution problem over Canada's wide areas also has to be considered. Accordingly, in my opinion, there are not more than two dozen chemicals which can be manufactured in Canada sufficiently cheaply to compete with American competition even after a moderate tariff is placed against importation. The major number of chemicals, it may be mentioned here, enter Canada duty free.

Only in those chemicals in the manufacture of which our natural advantages outweigh the above mentioned disadvantages, can we compete on an even basis. These chemicals are limited practically to the products of the wood distillation industry and to those in which water power is one of the principal elements of cost, since, in general, insofar as raw materials for the industry are concerned, few, if any, are available in Canada which are not found in the United States in larger quantities and often of better quality. To these, however, might be added the heavy chemicals, such as muriatic and sulphuric acids and Glauber salts,

which on account of transportation expense must be manufactured locally in the centres of industry.

Until the beginning of the war the principal chemicals manufactured in Canada, outside of explosives, were sulphuric, muriatic and nitric acids, Glauber salts, caustic soda, bleaching powder, wood distillation prod-



H. W. MATHESON
Vice-President Canadian Electro Products Co., Ltd.

ucts and one or two products of the electric furnace, such as calcium carbide, cyanamide and phosphorus.

The war brought into being one or two new chemical industries, among which may be mentioned the manufacture of acetone and butanol from grain, and the manufacture of acetone, acetic acid, acetaldehyde, and allied products from calcium carbide. The former industry, viz., the manufacture of acetone and butanol, disappeared from Canada at the end of the war, the manufacture of acetone by such a process being unable to compete with that from wood distillation, and the markets in Canada for butanol being extremely limited. The latter industry, viz., the manufacture of acetic acid, acetaldehyde, and allied products from calcium carbide, still maintains a struggling existence. This, however, is not due in any degree to the extent of the Canadian markets, but is due entirely to the uncertainty of present and prospective markets in the United States and Great Britain. Those with foresight believe that sometime in the distant future, acetic acid as made from wood distillation products will decline in extent as the forests become depleted, and that eventually acetic acid from carbide will predominate.

This stage of development of the industry, however, is considered a long way in the future, and for many years to come keen competition will be experienced between the two distinctive methods of manufacture.

Meanwhile, however, the markets for acetaldehyde and paraldehyde have grown steadily in importance, and the field here is considered to be very extensive potentially. The production of synthetic resins from acetaldehyde and phenol is now an established industry. Aldehyde ammonia and other products from acetaldehyde are becoming well known and effective accelerators in the vulcanization of rubber. Acetaldol bids fair to be an effective substitute for flotation oils in the concentration of copper ores. The use of these materials, however, in large tonnage awaits the revival of industry.

Up to the present time calcium carbide and acetic acid have entered the United States duty free. In the tariff bill now before Congress, is placed a duty of \$20 per ton on carbide and \$40 per ton on acetic acid. In addition paraldehyde, acetaldehyde, aldehyde ammonia and acetaldol is taxed 6 cents per pound plus 30 per cent. If this tariff bill is approved by the Senate, the United States Government will have placed a prohibitively high rate of duty on several products which are not now made in the United States in commercial quantities. Prior to the Emergency Tariff Act these materials were taxed 15 per cent. ad valorem.

Many Canadian business men feel strongly that such tariff actions are inadvisable and uneconomical. One corporation in the United States now controls 83 per cent. of the total carbide sold in the United States. The proposed tariff bill gives this company a complete monopoly. The high tariff placed on chemical products made from carbide is designed apparently with the same object in view, viz., to give this company a monopoly some time in the future when their processes are developed.

If the proposed Fordney tariff bill is enacted certain Canadian manufactures will be placed in an extremely awkward situation. If existing products cannot be manufactured which have a world market, and which can be manufactured here most cheaply due to advantageous economic conditions, then such plants must be diverted to the manufacture of chemicals which from the very nature and extent of Canadian markets can-

not be manufactured economically in Canada, but which, however, may be done temporarily if the existing government will afford sufficient protection. What is the eventual result of such a procedure? The ultimate consumer pays, and pays heavily for such errors in economic policy, and the manufacturer constantly has before him the danger of extinction as the political pendulum swings from one political party to the other.

Canada imports at the present time \$30,000,000 worth of chemicals from the United States, which amounts to 90 per cent. of the total chemicals imported into Canada. If we exclude explosives and cyanamide the total chemical materials exported from Canada to the United States amount to only \$10,000,000, which amount is a negligible quantity compared with the enormous production of the United States, and small in comparison with the United States exports to Canada.

The result of the new tariff bill will be to cut our exports in chemicals to the United States to the vanishing point. The tariff now proposed is, to the mind of the Canadian manufacturer, not one of protection for home industries but one of absolute exclusion of our products. Most certainly, in so far as the products above mentioned are concerned, their exportation to the United States from Canada under such tariff regulations is impossible.

It is not the writer's opinion that the United States, under present conditions, can lower advisedly her tariff walls. It is conceded readily that a moderate amount of protection is desirable and necessary, especially for infant industries. It is difficult, however, to conceive why such industries as wood distillation which is native to the United States and in which she controls about 70 per cent. of the world's production, and the carbide industry which is now practically a monopoly of one company, should require a protective tariff so high as to exclude all foreign products, whereas the infant dye industry is refused a measure of protection commensurate with its transcendent importance.

The argument of the German menace, which applies most particularly to the dye industry, is the one advanced, but those familiar with the German industry know that Germany lacks waterpower and that German carbide is of such inferior quality, due to the quality of her coal, that no competition need be feared from her in carbide or carbide products. Carbide also for many years has been on the free list, and no carbide or carbide product ever has entered the United States markets from Germany. In any case American protection from German competition in carbide and all its products could be obtained by a provision relating to the importation of products from all countries favored by adverse exchange and depreciated coinage.

The population of Canada is settled on a comparatively narrow strip of territory extending for over 3,000 miles on the United States border. For sentimental reasons her channels of trade have been encouraged East and West. This, however, does not alter the fact that her natural channels of trade are north and south. This is even more true today than in the past, due to the increasing cost of transportation. As time goes on it is hoped that statesmen on both sides of the line will realize this fact, which is of the greatest importance to the economic growth of both countries, and that reciprocal trade relations will be made accordingly.

The present proposed tariff legislation in the United States, giving as it does a severe blow to the great mass of our electorate, viz., the farmers, if enacted, will postpone for an indefinite period any such considerations. Canada in self defense must impose similar barriers

against the importation of foreign goods and which eventually will have the effect of greatly decreasing the present large volume of imports from the United States.

It is hoped that the sound common sense of American business men will appreciate the situation and allow Canada to continue to export to her territory those few chemical products which because of natural advantages can be manufactured most economically, in return

for purchases by Canada of chemicals vastly greater in number and in value, and which for many years to come cannot economically be manufactured within her borders.

Under such conditions the chemicals, manufactured in Canada, for many years will remain comparatively few in number and will consist of those whose manufacture is founded on sound economic principles and the great bulk of our supplies will come as at present from the United States.

Muscle Shoals and Henry Ford

SECRETARY OF WAR WEEKS' willingness to recommend to Congress that appropriations necessary to complete the work at Muscle Shoals be made, provided some substantial business concern would agree to take over the project on such terms as would benefit the nation and the Government, has found response in Henry Ford's proposal to take over the Government's nitrate plant for conversion into a fertilizer plant under a 100 year lease, involving a cash payment of \$5,000,000 and an annual obligation of \$1,500,000 for 100 years.

The principal points of Mr. Ford's offer which requires Congressional acceptance are:

I. Mr. Ford will take a 100 years' lease upon the Wilson dam and No. 3 dam and electric installation when completed. This work is estimated to cost \$28,000,000. After a short preliminary period Mr. Ford proposes to pay interest at the rate of 6 per cent. on the \$28,000,000 and to amortize not only this sum but the entire cost of both dams over a period of 100 years.

II. Mr. Ford will purchase all the nitrate plant and equipment, lands and steam plant, for \$5,000,000.

III. He will convert and operate Nitrate Plant (No. 2) for the production of fertilizer compounds and as a standby for Government explosives in case of war and to keep it up to date in both arts.

IV. He will limit the profits of the fertilizer plant to 8 per cent. An independent board embodying representatives of the American Farm Bureau and the National Grange and the Farmers' Union will certify to this maximum profit.

Henry Ford's proposal to acquire the Muscle Shoals nitrate and water power property has excited popular imagination and won a measure of popular approval, judging from the daily press. Farmers who have not got out of their heads the erroneous notion that the Muscle Shoals plant is capable of producing sulphate of ammonia cheaply enough to compete with by-product coke ovens, would like to have Mr. Ford try it at his own expense. The public generally, having been led to believe that Muscle Shoals is a great "white elephant," would like to have Mr. Ford or anyone else take it off the government's hands.

We venture to say, however, that very few farmers or others who are said to be urging upon the Secretary of War the immediate acceptance of the Ford offer ever have read or analyzed it—and in this statement we include the editors of the daily press. Even with the proposal before us, we must know something of the facts regarding the Muscle Shoals property in order to understand it. In the light of these facts, several things are apparent, viz.:

I. Mr. Ford does not propose to take any "white elephant" off the Government's hands, but merely to have the Government in effect loan him approximately \$57,800,000 at a little less than 3 per cent. interest per annum.

II. Mr. Ford does not agree to make fertilizer materials unless he determines "by research on a commercial scale" that he can do so at a profit. If his de-

termination is, like that of well-informed members of the chemical industries, that he cannot make fertilizer materials at a profit at Muscle Shoals, he is not bound to go ahead with the fertilizer operation.

III. In fact, Mr. Ford does not by his proposal bind himself to anything at all. He points out that "many details" must be arranged by contract, and if these details are not arranged to his satisfaction he may withdraw from the situation after collecting a great deal of free advertising.

Part of the Ford proposal involves his purchase for \$5,000,000, of the following properties upon which the Government has spent, according to the Select Committee on War Expenditures of the House of Representatives, a total of \$87,365,135.47, divided as follows:

CONSTRUCTION	COST
a. Nitrate Plant No. 2 with its 80,000 H.P. Steam Plant.....	\$69,985,221.42*
b. Nitrate Plant No. 1 with its 5,000 H.P. Steam Plant.....	12,152,636.91
c. Waco Quarry.....	60,000.00
d. 40,000 H.P. Steam Plant at Gorgas, Warrior River.....	2,811,980.00
e. Transmission Line—Gorgas to Muscle Shoals	2,355,297.14
*Total	\$87,365,135.47

The Ford purchase price is obviously not more than the salvage value which reasonably could be figured at ten per cent. at the very least, especially since the three steam plants with installed capacity of 125,000 horsepower have a very high salvage value. The transmission line from Gorgas to Muscle Shoals is 80 miles long. There is also a transmission line connecting Nitrate Plant No. 1 and Nitrate Plant No. 2, not included in the above figures, because the line was built after the figures were assembled by the Committee on War Expenditures. On the Waco Quarry and certain improvements to Nitrate Plant No. 2 additional items of about \$1,250,000 also were expended that are not included in the committee's report.

But the main part of the Ford proposal relates not to the purchase of property listed above, but to the lease of the water power. The stipulations as to the water power are interesting in the extreme and bound, we believe, to cool the enthusiasm of anyone who examines the proposal as carefully as we feel sure the Secretary of War will examine it before he asks Congress for authority to make the deal with Mr. Ford.

In the first place, the Government is required to complete at its own expense Dam No. 2, popularly known as the Wilson Dam, and Dam No. 3.

The former has been partially built at an expenditure of \$17,000,000. To complete it, with its power house, will cost an additional \$33,000,000, according to the testimony of Col. Hug' L. Cooper, consulting

*Report No. 998, Sixty-sixth Congress, second session.

engineer of the War Department, before the House Appropriations Committee of the last Congress. This estimate, furthermore, is based upon the installation of electrical generating equipment for only 550,000 horsepower, whereas Mr. Ford requires generating equipment for 600,000 horsepower. The additional generating equipment required by Mr. Ford will cost at least \$1,000,000, making a total of \$34,000,000 to complete Dam No. 2.

Dam No. 3 is 6,000 ft. long and 50 ft. high; Dam No. 2 is 4,000 ft. long and 90 ft. high. By comparison it may be estimated that Dam No. 3 will cost \$23,-800,000.

So the additional money the Government must spend to complete these two dams is \$57,800,000 if the estimates of its own engineers are not exceeded.

Mr. Ford proposes that he shall pay 6 per cent. interest on the additional money the Government must invest, "taken" at \$20,000,000 for Dam No. 2 and \$8,000,000 for Dam No. 3. In other words he will pay 6 per cent. interest on \$28,000,000 or an annual rental of \$1,680,000. This is only two and nine-tenths per cent. on the \$57,800,000 that the Government must add to its present \$17,000,000 investment in the water power!

The Government now borrows money at $5\frac{1}{2}$ per cent. on twelve-month notes. At that rate, it will pay \$3,179,000 annual interest on the new money it must put into Muscle Shoals under the Henry Ford proposal, or \$1,499,000 per year more than Henry will pay. Thus instead of taking a "white elephant" off the Government's hands, Mr. Ford proposes to add to the Government's burdens to the extent of an annual loss of \$1,499,000.

The provisions regarding the manufacture of fertilizer materials are full of suggestions as to possibilities interesting to farmers, but do not definitely commit Mr. Ford to a manufacturing program. In point of fact, he could not very well so commit himself, because this is a new field for Mr. Ford, and one which the best informed experts have declared would bring only disaster to anyone operating the Muscle Shoals plant to compete in the present or prospective market with the by-product coke ovens.

Mr. Ford agrees to operate the big cyanamid nitrate plant only to carry out certain "special objectives." One of these is to maintain it in a state of readiness to make munitions in case of war, but this the Ordnance Department already has determined can be accomplished without operating the nitrate plant at all. The other is "to determine by research on a commercial scale whether by means of electric furnace methods and industrial chemistry there may be produced fertilizer compounds of higher grade and at cheaper prices than the fertilizer-using farmers have in the past been able to procure, and to determine whether in a broad way the application of electricity and industrial chemistry may do for the agricultural industry of the country what they have economically accomplished for other industries."

If the "research on a commercial scale" shows the impracticability of the commercial operation of the Muscle Shoals plant to produce fertilizer materials, Mr. Ford will be relieved of any obligations so to operate it.

In one of his final paragraphs, Mr. Ford remarks:

"It will be obvious to you that, should the above proposals and offers of the company he accepted by the United States, there will be many details in the lease and purchase agreements to be worked out; but it is believed that the above will furnish all of the in-

formation required for decision by the United States upon the tender herein submitted."

In other words, the offer is held to be sufficient for a decision by the United States, but either party must reserve his right to disagree when the "many details" are being worked out. That kind of an offer does not bind anybody inescapably to anything.

Doubtless much can be done in industry with cheap power. As much can be done by Mr. Ford as by any other captain of industry. But it is hardly in the real interest of industry—and certainly not to the interest of the Government—that Mr. Ford or anyone else should be supplied with exclusive rights to cheap power at the expense of the people.

Walter G. Campbell, Acting Chief, Bureau of Chemistry, U. S. Department of Agriculture

The appointment of Walter G. Campbell as acting chief of the Bureau of Chemistry to succeed Dr. Carl L. Alsberg, who has been appointed director of the departments of production and distribution of the Food Research Institute of Stanford University, provides for the inter-regnum incumbency of one of the most important offices in the scientific activities of the government, pending the selection of a permanent chief.

Mr. Campbell has been with the Bureau since 1907, when he was called from his work of assisting in enforcing the State food drug laws of Kentucky, and was selected by Dr. H. W. Wiley, then chief of the Bureau, as chief inspector to organize the inspection work under the Federal Food and Drugs Act, which became effective at that time.

Upon the reorganization of the Bureau of Chemistry in 1914, he was made chief of the eastern food and drug inspection district, and in December, 1916, was promoted to assistant chief. Mr. Campbell has been largely instrumental in organizing the field work of inspecting interstate and foreign commerce in food and drugs. He is 44 years old, a native of Kentucky, and a graduate of the University of Kentucky.

Mr. Campbell is succeeded by Dr. W. W. Skinner, chief of the water and beverage laboratory of the Bureau since 1908.

Dr. Skinner entered the service of the Bureau in 1904, and has had considerable experience in agricultural chemistry, having been connected as a chemist with the Maryland Agricultural College, now part of the University of Maryland, and the Arizona Experiment Station. He has had charge of the beverage work of the Bureau in the enforcement of the Food and Drugs Act. He was born in Baltimore in 1874, and received the degree of Bachelor of Science at Maryland College in 1895 and Master of Science at George Washington University in 1897. The Maryland institution has since conferred upon him the degree of Doctor of Science.

At the recent Annual Convention of The National Fertilizer Association at White Sulphur Springs, W. Va., Charles H. MacDowell, president of Armour Fertilizer Works, was re-elected president of the association. Ninety-four per cent. of the company members were represented at the convention and much constructive work was put through, including adoption of Secretary Hoover's plan for centralization of trade statistics through the Department of Commerce. This is Mr. MacDowell's fourth term as president of the Association, he having been previously elected to that office in 1903 and 1904 and again in 1920.



View of Marcus Hook, Pa., Plant of The Viscose Co.

Origin, Development and Present Status of the Industry of Artificial Filament Formation, with Especial Reference to the Production of Cellulose Sulphocarbonate (Viscose) Filaments, or Wood-Silk.

THE manufacture of artificial silk is essentially an imitative industry, and a forgery of the patient and delicate workmanship of the silkworm, *Serica mori*. That, of all the textile fibers, silk is the most costly and most highly prized although the simplest in structure, undoubtedly accounts for the fact that the silk industry is one in which production never has been in excess of a constantly increasing demand. It therefore is natural that a subject so alluring should early have engaged the attention of chemists and financiers, in early endeavors to prepare substitutes which would possess the desirable properties of luster, elasticity and strength of the natural filament.

The early investigators reasoned that the silk fiber being devoid of cellular structure and consisting primarily of the solidified liquid contents of the glands of the silkworm, would be apt to offer a much more lucrative field for experiment in attempting to imitate it artificially, than would the less expensive and more highly organized fibers of wool and cotton. These "silk alchemists" reasoned that it would be necessary only to project an acceptable liquid of known viscosity and total solids through an orifice of predetermined diameter into a coagulating liquid to form filaments like natural silk, which would be insoluble in water and of sufficient strength and elasticity to admit of spinning and weaving without serious deterioration. The entire problem is comprised in the foregoing sentence and yet has been unsolved in two particulars, viz., a solution has not been found which immediately would set to an insoluble fiber of the required strength when projected into air as occurs in nature, and secondly from a chemical viewpoint, the fluid present in the gland of the silkworm differs from spun silk only in being a liquid, because as soon as it is artificially removed for purposes of analysis, it becomes hard and apparently is identical with the spun filament.

Origin of the Art

The development of the artificial silk industry is a narrative of mechanical and chemical difficulties overcome and ingenuity displayed in formulating ways and means whereby some form of cellulose, usually cotton

or wood pulp, is dissolved and attenuated into merchantable filaments, and strikingly exemplifies the fact that man has learned to apply practically the lessons taught by Nature for his own advancement and comfort.

Whatever nebulous ideas floated through the minds of the earlier investigators, it was Reaumur who in 1734 first intelligently explained the methods of the silkworm in filament formation, and conceived the idea of accomplishing the same result artificially. It was he who showed that silk was the product of certain glands located on the under side of the body of the silkworm, and that a portion of the albumen of the silkworm's food is transformed into fibroin and secreted in the glands. It therefore was quite natural that he should have propounded the question whether it might not be possible and economically practicable to spin other semifluid materials, such as, for example, certain varieties of pitch into thin filaments and thus produce a silk-like substance equally as serviceable as the fibroin of the silkworm.

One hundred and fifty years elapsed before experience had been accumulated to attack the problem in a successful manner.

In 1855 the idea was revived by Andemars of Lausanne who combined nitrated mulberry leaves with rubber, forming a solution which he drew out into a thread. Apparently he considered that nitrocellulose made from mulberry, the natural food of the silkworm, must possess peculiarly desirable properties. Many took up the subject from this point, but it was not until Chardonnet in 1884 prepared a nitrocellulose artificial silk that had distinct commercial value, that the problem can be said to have been solved technically. The ingenuity involved in attempts to perfect this art may be gauged from the fact that in the monumental treatise of the industry are enumerated over 2,000 patents and contributions upon this phase of technical advancement alone.

Classes of Artificial Silks

Four classes of artificial silks are found in the trade, viz., filaments made from (1) nitrocellulose, (2) cuprammonium cellulose, (3) cellulose acetate, and (4)

viscose. Filaments produced from gelatin, casein, glue and similar materials have proved inferior industrially and are no longer made. All employ some form of cellulose placed in solution, which solution is projected under pressure through microscopic orifices or spinneretts into a coagulating medium, whence the precipitated material in a continuous thread is wound on bobbins, further treated by washing, bleaching and dyeing into the finished fiber of the trade.

Nitrocellulose Silk

The first filament produced commercially in large amounts was of nitrocellulose. In 1884 Count de Chardonnet deposited a sealed document with the French Academy of Sciences, which when opened three years after, contained a description of his process of preparing nitrocellulose and squirting an ether-alcohol solution of it through minute apertures into the air. The various refinements and modifications of this original process were defective in one particular, viz., the filament produced was equally inflammable with the pyroxylin from which it was produced. To diminish the inflammability it was necessary to remove the nitrogen from the finished silk by a denitration process which materially decreased the yield.

Cuprammonium Silk

"Cuprammonium" is a general term applied to those artificial filaments which result from dissolving cellulose in an ammoniacal copper solution, forcing the solution through microscopic orifices into a coagulating medium, and regenerating the cellulose from the copper-containing compound. The first patent connected with this process was taken out in France by Depeissis in 1890, improved upon by Pauly seven years later, and now successfully manufactured in large quantities, especially by the Vereinigte Glanzstoff-Fabriken in Germany, whose product is called Glanzstoff silk. Givet silk, Soie de Paris, Artiseta and Lustracellulose are other trade names applied to this product.

As compared with those prepared from the cellulose nitrates, the cuprammonium silks are not inflammable or combustible, are equal to the former in tenacity and elasticity, but do not possess the scroop (rustle) of natural silk. The methods of manufacture are free from danger as no inflammable solids or liquids are employed. The denitration process, so troublesome and expensive in the Chardonnet method, has no counterpart in cuprammonium filaments. While it might seem that the absence of denitration would place the cuprammonium silks at a much greater advantage as to cost of production, the advocates of nitrocellulose silks have called attention to the multitude of mechanical refinements in production to offset this.

Acetate Silk

In the United States cellulose acetate silk has been developed by H. Mork for the Lustron Co., and abroad by the Dreyfus Brothers in their Swiss and English plants, the latter having a daily production of one ton or more. Acetate silk differs from all other artificial silks in being an ester in the final merchantable form; whereas the nitrocellulose, cuprammonium and viscose filaments are some form of hydrolyzed cellulose. The acetate silks are distinguished by their great firmness, tensile strength and elasticity.

Unlike the other filaments they are less affected by dampness and water, but the dyeing of these fibers until lately has been a difficult problem due to the unevenness with which the silk absorbs the dyestuff. Due

to the researches of Dreyfus, methods have been patented whereby this disadvantage is said substantially to have been overcome. The world's present daily production of cellulose acetate silk has been estimated at about 2,500 pounds.

Viscose Silk

Viscose is the name given to the cellulose sulphocarbonates by their discoverers, Cross, Bevan and Beadle. A method of manufacture for this class of bodies was first granted in England in 1892. They found that when wood pulp is treated with concentrated caustic soda solution, the excess of soda pressed out, and the alkali cellulose thus prepared treated with carbon bisulphide, after several hours' digestion a homogeneous viscous liquid is obtained of value for artificial filament production. In pounds of silk produced and in extent of capital invested, the viscose silks lead all other imitation filaments at the present time.

The centers of production are in England at the Courtauld, Ltd., plant at Coventry; in Belgium at Tubize near the battlefield of Waterloo; at Savar, Hungary; Tomazow, Poland; Kelsterbach near Mayenne, France; and in the United States, the American Viscose Co., at Marcus Hook, Roanoke, Va., and a new plant soon to be erected at Lewiston, N. J. The Roanoke plant is about to be doubled in capacity. The combination of the du Pont interests with the Comptoir des Textiles de Paris in the formation of the du Pont Fibersilk Co., with plant on the Niagara River near Buffalo, has a present daily production stated as 1,500 pounds.

Viscose Silk Manufacture

Much inventive ingenuity and a prodigious amount of chemical experimentation have been brought to bear upon the perfection of the many steps in the production of viscose silk, and notwithstanding the processes evolved, patented methods published, and technical descriptions which have appeared in the literature, so zealously have the factory details for the production of viscose silk been safeguarded, that up to the present but little information of an authentic nature as to the methods of manufacture of this product, in which over forty millions of dollars is invested at the present time, has appeared.

Raw Materials of Viscose Manufacture

But three raw materials are required in substantial quantities for the production of viscose filaments, viz., caustic soda, carbon bisulphide and wood pulp.

The caustic soda must contain a minimum of 97 per cent. sodium hydroxide, not over 1 per cent. sodium carbonate, not to exceed 1.25 per cent sodium chloride, with combined iron and copper of less than 0.01 per cent. The soda must dissolve clear in water to 17.5 per cent. strength. The presence of unduly large amounts of salt in the caustic soda causes a turbidity in the concentrated solutions; while the presence of carbonates is decidedly detrimental, for in forcing the fluid viscose solution through the spinneretts into an acid coagulating bath, the evolution of carbon dioxide from the alkaline viscose solution causes contortion and unevenness of the viscose filament.

The carbon bisulphide must be substantially free from dissolved sulphur and polysulphides, of specific gravity 1.29-1.30, dissolving not over 0.3 per cent. in water at room temperature, and giving not over 0.2 per cent. of residue upon evaporation. Great care must be exercised in storing this material on account of its extreme volatility, the explosiveness of its mixture with

air, and the fact that its products of combustion are the three irrespirable gases, carbon dioxide, sulphur dioxide and nitrogen.

There is as decided lack of unanimity of opinion as to the specifications for wood pulp most suitable for viscose formation, as there is in the selection of wood pulp for nitration. The moisture and alpha-cellulose should be low, resins and ether-extract practically nil, ash not to exceed 3 per cent. and solubility in caustic soda reduced to the minimum. Silicates should be absent or in traces only.

Preparing the Caustic Soda Solution

Two strengths of sodium hydroxide are required, a 17.5 per cent solution for treatment of the wood pulp for alkali cellulose formation, and a 35 per cent. solution to fortify the weaker solution after use. Several drums of caustic soda, with casings removed, are hoisted into a heavy iron upright cylindrical tank with perforated diaphragm, upon which the caustic is deposited. Near the top of this "dissolver" is a circular pipe with small holes facing inward and downward, through which water is added.

After the required amount of water has been added, the contents of the lower part of the dissolver are pumped over the caustic again by means of the spray arrangement, and this circulation continued until all the alkali has been dissolved. Circulation is then continued for a further period of 15 minutes, when a test sample is taken, titrated, and water or caustic added to make the strength 17.5 per cent. NaOH. After allowing the contents of the dissolver to settle for two or three hours, the caustic solution is run out and through a plate filter of the Kelly type, containing filter cloths of cotton batten between layers of cheesecloth, the clarified alkali being then run directly to iron storage tanks immersed in water for the better equalization of temperature.

Alkali-Cellulose Manufacture

The wood pulp is received in large sheets done up in bundles, the sheets upon arrival being placed one in each bin or shelf in order to obtain a cellulose of maximum uniformity in composition and moisture-content. These sheets are then cut to the desired size by means of the ordinary paper cutter. In the air-dry condition one gram of pulp is about 3.4 square inches. From 11x14 to 12x18 inches is the usual size of sheets for mercerization and alkali-cellulose formation. Great stress is laid on the uniformity in composition of the wood pulp, and the correctness of temperature of the caustic soda solution when acting upon the cellulose.

In the mercerizing process, stoneware tanks heavily reinforced by iron on the outside are used, the tank being arbitrarily divided into a number of sections or septums by means of Monel metal plates, the whole forming a plate filter-press actuated by means of a hydraulic ram with accumulator. To load the mercerizing tank, from 12 to 20 sheets of wood pulp are placed between each filter plate and closely packed, caustic soda solution of 17.5 per cent strength at about 20° C. being

then admitted until the sheets of pulp are covered and with one-half inch of solution above the tops of the sheets. The solution may or may not be circulated during the steeping period which is 1.5 hours in the best practice.

During the steeping operation the temperature of the room is kept between 18° and 20° C., the uniformity of temperature being greatly facilitated by constructing the roof in the form of a tank wherein a foot of water is allowed to circulate continually by means of an automatic overflow with float. At the close of the steeping period, the caustic solution is first allowed to run off by gravity, and this weaker solution fortified to 17.5 per cent. strength again by means of the concentrated (35 per cent.) caustic solution and re-filtered.

When all the caustic that is removable by gravity alone has been recovered, the hydraulic plunger operat-



Roanoke, Va., Plant of The Viscose Co.

ing on the plates is started and a further quantity of caustic solution obtained, which is discarded, pressure being applied until the "cake" formed consists of about one part of original cellulose to three of caustic soda solution, i. e., the mass consists of alkali-cellulose containing free sodium hydroxide and water.

These cakes are placed in a disintegrator or dough mixer of the Werner-Pfleiderer type where they are broken up into small fragments called "crumbs" after about 15 minutes' agitation, the process being technically designated as "Pfleidering." The length of time of the mixing operation is governed by the speed of the agitators and the toughness of the alkali-cellulose.

Maturing the Alkali-Cellulose

The crumbs of finely-divided alkali-cellulose are placed, about 60 pounds to a box, made of material not acted upon by caustic soda and transported to the maturing or ageing room, where it remains for 55 to 60 hours at a temperature of 17.5° to 20° C., frequent viscosity determinations being made of a caustic soda solution of the pulp to determine the degree of maturing.

As little time as possible is allowed to elapse between the drainage of the caustic soda from the alkali-cellulose, and its transfer to the ageing room. This latter is kept at a uniform temperature by means of refrigeration and by steam coils. The desired degree of ageing is determined by the viscosity and solubility of alkali-cellulose in sodium hydroxide solutions of definite strength.

Cellulose Xanthate (Viscose) Formation

The next step in the process is the transformation of the aged alkali-cellulose into cellulose sulphocar-

bonate (viscose) by means of carbon disulphide. The boxes are mechanically transported, usually by endless belt, from the ageing to the "xanthating" room, the latter being on the second or third story, for gravity emptying. The transformation from alkali-cellulose to xanthate takes place advantageously in a hexagonal or octagonal churn, in which is led a small pipe with spray nozzle. The light-gray or yellow alkali-cellulose having been introduced into the churn by means of a man-hole, the cover is affixed and the churn revolved slowly. The stream of carbon disulphide is then turned on, the contents meanwhile being continually agitated.

By means of a small window located in the churn the progress of xanthate-formation may be observed, and as combination between disulphide and alkali-cellulose proceeds, the color of the product gradually changes to a deep carrot. The rotation is so adjusted and the addition of disulphide so governed that the mass never sticks together. In this manner maximum uniformity of composition of the cellulose xanthate is assured.

After revolving for about half an hour, twenty minutes of which is taken up by the addition of disulphide, the mass is thinned by the addition of caustic soda solution and allowed to flow into the ageing vats—long cylindrical boilers maintained at a temperature of about 20°—where after several days' rest with from 2 to 4 filtrations at various stages of the ageing process, the dark colored solution is given a final filtration and pumped to the individual filament-forming machines to be transformed into filaments.

Spinning the Viscose Solution

From the final viscose reservoir the solution, under a pressure of 40 pounds, is forced through the spinning-head into a coagulating or precipitating bath. The spinning-head comprises a bent glass tube at the end of which is affixed the platinum spinneret containing usually 18 holes each of 0.004-0.005 inch in diameter. Thus there is simultaneously forced out of each spinneret eighteen separate filaments which are received into an aqueous solution of sulphuric acid, sodium sulphate and glucose. The sulphuric acid neutralizes the alkali which holds the viscose in solution and suspension and therefore causes its precipitation, and its almost instantaneous conversion into a filament of considerable tensile strength upon striking this solution.

The threads are allowed to pass for about nine inches through this solution (spinning bath) when they are caught under a glass hook and then carried up and out of the solution over a 6 inch Godet wheel revolving at 120 r. p. m., the direction of the thread being changed by being carried downward through a glass funnel by pouring from a small beaker a solution into the funnel, thus carrying the thread with it.

The speed of the centrifugal is so regulated as to give the proper twist to the 18 filaments to form a single thread, and at the same time to coil it up in a proper manner inside the basket, at the same time centrifugally removing the excess of solution. If the viscose after delivery to the spinneret contains suspended particles of iron or other matter, the holes become clogged. The temperature of the spinning bath is maintained at 45° C.

The spun silk or "cake," as it is called, is removed from the centrifuge and stored in cabinets for a short period to allow for complete coagulation of the interior of the individual filaments. The cabinets are regulated to a temperature of 75°-78° C., with a humidity of 100 per cent. The silk is next reeled into skeins 22

inches long, the reeling machines being operated by girls who become very dexterous at this work, some being able to reel 800-850 skeins per day.

After-Treatment of the Spun Viscose

The skeins are put through a washing machine and washed for 10-15 minutes by means of a water spray, at the end of which operation they must respond neutral to methyl orange, the washing treatment being continued until they do so. The temperature of this wash-water should not be allowed to rise about 30° C.

The skeins then are partially dehydrated centrifugally; then put on stretching racks and placed in an oven to partially dry, this latter process improving the gloss and luster of the silk, the temperature not being allowed to exceed 60° C.

In the further finishing of the silk it is desulphurized by spraying with a 1 per cent. solution of sodium sulphide which combines with the sulphur forming polysulphides, and regenerating the cellulose in a hydrated form. A very important consideration is that if any copper or iron is present in the caustic soda used and should be carried through the operation to this point, the silk may be stained and thus materially interfere with evenness in the dyeing operations, for the bleaching operation is usually too delicate to remove all traces of iron and copper.

After the skeins have been hung on hard rubber rods and passed through the spray of 1 per cent. sodium sulphide for 15 minutes and then washed for an equal length of time, bleaching is carried on by spraying over the filaments a solution of bleaching powder of 0.1 per cent. available chlorine. After a quarter hour's contact with the bleaching solution, followed by a thorough washing until the skeins fail to turn blue upon application of starch iodide, the silk is immersed in 1 per cent. hydrochloric acid, followed by a final wash in clear water for a half hour or until the wash-water reacts neutral. The skeins are then centrifuged and dried at a temperature of 60° C. under considerable tension.

World's Output of Viscose Silk

The production of all kinds of artificial silk which in 1902 was 4.4 million pounds, rose in 1906 to 13 million, and in 1914 to 17.6 million pounds. Naturally, output was checked during the war and was slow to get under normal production after the cessation of hostilities due to the fact that the majority of these plants were transformed into munition plants soon after the outbreak of hostilities.

Of viscose silk the Marcus Hook plant of the American Viscose Co., is said to produce 6 million pounds yearly and the Roanoke plant of the same company about half as much. Add to this a present daily production of 1,500 pounds by the du Pont Company, and we have an annual output in the United States estimated at 9.5 million pounds. Estimates have given the production of the English plant at Coventry at 7.5 million pounds, and the combined European production at 10 millions, or an apparent grand total of 22.5 million pounds of viscose silk manufactured annually.

It is a significant fact that the increasing activity of the artificial silk industry, rather than curtailing the production of natural silk has, on the other hand, augmented it. The production of natural silk increased from 41.9 millions of pounds in 1904 to 48.5 millions in 1914.

The Union Sulphur Co. is now installed in its own property, the Frasch Building, at 33 Rector St., New York City.

American Institute of Chemistry

Some History of Chemical Organization in Great Britain and Some Comparisons

AS English institutions all over the world trace their lineage to a common Anglo-Saxon origin, so is it natural for English-speaking people to seek precedent and analogy for their social enterprises in similar undertakings at the common source of our law and literature. In America particularly originality and initiative in many lines have so far outstripped the enterprise and needs of our racial progenitors as often to reverse the position of preceptor and pupil.

We are concerned here with the activities of chemically educated men in the development and expression of class consciousness and resort to Great Britain to find what has been done there. Geographically limited in comparison with America, we find there a compactness and congestion and a corresponding accessibility foreign to our experience and a political unity quite in contrast to our 48 separate states with physical environments and industrial activities peculiar to each or to groups of states.

Early Chemical Societies

From the Royal Society of London, founded in 1660 and regarded as the parent society of scientific bodies in that country, to the establishment of the British Association for the Advancement of Science in 1831, several societies devoted to the advancement of science, including chemistry, were organized and persist today. The British Association for the Advancement of Science provided for a chemical section, but no strictly chemical society existed in the world until 1841, when the Chemical Society of London was founded "for the general advancement of chemical science by the discussion and publication of new discoveries and interchange of valuable information respecting them," which was incorporated under Royal Charter in 1848.

In 1841 also was founded the Pharmaceutical Society of Great Britain, incorporated under Royal Charter in 1843 and notable in this connection "for the protection of *chemists and druggists*." The Royal Society of Arts established in 1874 a section devoted to the discussion of subjects connected with the application of chemistry to industry, which after having demonstrated its usefulness it relinquished in 1886 to the Society of Chemical Industry, which had been formed in 1881.

Origin of the Institute of Chemistry of Great Britain

In 1867 a discussion of membership qualifications was had among the members of the Chemical Society. Some contended that membership in the society should confer distinction on the holder, who therefore should have been required to show that he was entitled to be regarded as competent to practice chemistry. Others

maintained that the charter intended as eligible for membership any one interested in chemistry, provided he had procured the necessary recommendation of three members.



SIR EDWARD FRANKLAND,
K.C.B., D.C.L., F.R.S.
Founder and First President (1877-1880) of
the Institute of Chemistry of Great
Britain and Ireland.

The subject of segregation continued in process of incubation until 1872, when Prof. Edward Frankland, then president of the Chemical Society, in the course of an address dwelt upon the increasing importance of chemistry to human needs and emphasized the usefulness of an institute which would be to chemists what the Royal Colleges of Physicians and Surgeons were to the medical profession, the Institution of Civil Engineers to civil engineers and the Inns of Court to lawyers.

Parliament in enacting the Sale of Food and Drugs Acts in 1875 had recognized the applicability of analytical chemistry for the public benefit and paved the way for the organization in 1876 of the public analysts appointed under the act into the now well-known Society of Public Analysts, for the discussion and publication of papers relating to the detection and repression of adulteration in food and drugs.

Notable at this time was the general feeling among consulting and production chemists of the need of an organization to establish qualifications for practice and for raising the professional status of the chemist. The Sale of Food and Drugs Act had imposed a responsibility in the effort to fulfill which discrepancy and incompetence were displayed to the degree as to create distrust of the work of public analysts.

Condition of the Chemical Profession in England Fifty Years Ago

Dr. Adler Wright, prominent among the workers for an economic organization of chemists, in a contribution to the *Chemical News* of Jan. 21, 1876, wrote of the conditions of the profession of chemistry in England of that time. Dr. Wright said:

"In the absence of organization, and without due recognition by the public of the existence of the profession of chemistry, there was a general feeling that unless some steps were taken to ensure the proper training of professional chemists, their calling would be speedily reduced to a low standing in the public estimation; few men of culture would follow it, and the progress of chemical science thereby would be retarded.

"Apart from the science teachers and *dilettanti* workers, chemists had in most cases to combine teaching with their consulting and investigational work. Chemical practitioners included comparatively few who had received any systematic training in universities, or who had served under articles in the laboratories of reputable professional chemists; while there were many who as subordinate assistants to private practitioners

or in works, or as "bottle washers" in laboratories, had picked up a rough-and-ready knowledge of testing processes in use for the examination of a limited number of materials and products.

"There also were science teachers who supplemented their salaries by undertaking professional chemical work for which their experience and skill often were insufficient; and medical men with only a modicum of chemical knowledge, often wholly innocent of any notion of the conduct of quantitative work with perhaps a slight acquaintance with the methods adopted in the examination of a few articles of food and water.

"These quasi-chemists were unable to undertake any problem out of the common and, except where they referred it to better qualified men, would attempt it with fallacious results which were only brought to light when checked by others more competent. The public, being unable to discriminate between the competent and the incompetent, would throw discredit on both and on the profession generally. Such quasi-chemists, moreover, accepted absurdly low fees, with the consequence that the public often expected competent men to do the same. If the latter refused the work, they lost clients and income; while if they accepted it, the work had to be slurred over in some way, rough tests taking the place of accurate estimations requiring time and skill. In some cases, it was alleged that the results were simply the offspring of the analyst's imagination."

The Chemical Society

In the discussion of the subject at the time, as reported in the *Chemical News*, it was disclosed that the roll of the Chemical Society included amateurs and students who were not teaching or practicing the science and art of chemistry, and that not a few sought membership to support claims to scientific attainments in the estimation of the public. An element of the membership of the Chemical Society who desired to maintain the prestige of the society as a representative organization of chemists refused to vote for the election of any member who could not show evidence of scientific attainments to the end that the initials "F.C.S." (Fellow of the Chemical Society) might become an indication of professional qualifications and the Chemical Society the guardian of the professional interests of chemists.

The conclusion was expressed at the time that the public regarded membership in the Chemical Society as the recognition of knowledge and skill in the science of chemistry, but that as a matter of fact the roll of the society embraced the amateurs of every grade, with motives of affiliation often far without the purview of the society, and the workers, no distinction as to which being made.

It was admitted that the Chemical Society was not founded to separate the sheep from the goats but for the general advancement of chemical science and that membership growth was vital to the progress of the society because of its need for funds to meet the cost of its publications.

That the Chemical Society had performed all other functions was submitted as no excuse for neglect or refusal to cultivate the professional interests of those members qualified to call themselves chemists; that if such steps might conduce to the general advancement of chemical science, the society by failure to do so not only was not fulfilling the purpose for which it was founded but by opposition to the plan exposed itself to the charge of retarding the progress of chemistry.

The Die is Cast

In November 4, 1876, the Council of the Chemical Society declared that it would not sanction the creation of an Institute of Chemistry. Whereupon, at the instigation of Prof. Frankland, a committee was appointed to settle the form and details and to take all necessary steps to form and incorporate the new association, called in its early formative period, "The Institute of Professional Chemists."

Notable in Prof. Frankland's address at the first annual general meeting, Feb. 1, 1878, is reference to the fact that the Institute did not interfere with existing interests but that it met with considerable opposition and many difficulties.

Legal difficulties in the way of nomenclature and the intrusion of the interest of the Pharmaceutical Society of Great Britain, which pre-empted the exclusive title of "chemist," compelled the resolution of the name of the British economic organization of chemists into "The Institute of Chemistry of Great Britain and Ireland," thus exemplifying the general ignorance at the time of the existence of more than one class of chemists. On October 2, 1877, the organization was incorporated with Prof. Edward Frankland, president; Dr. Alder Wright, treasurer, and W. N. Hartley, secretary.

Objects and Administrators of the Institute

The objects of the Institute as defined in the articles of incorporation were as follows:

"To ensure that consulting and analytical chemists are duly qualified for the proper discharge of the duties they undertake by a thorough study of chemistry and allied sciences in their application to the arts, public health, agriculture and technical industry.

"To adopt such measures as may be necessary for the advancement of the profession of chemistry, and particularly for the maintenance of the profession of analytical and consulting chemist, on a sound and satisfactory basis.

"The doing of all such other lawful things as are incidental or conducive to the attainment of the above objects."

Within a short time there were but few men prominent in scientific and industrial chemistry who had not joined the Institute. Affiliation was with little or no thought of personal gain. They gave their material support and personal influence for the good of the profession. The Chemical Society, the Society of Public Analysts and the Society of Chemical Industry provided the means of discussion and publication of the methods and results of chemical investigation and discovery, with which the Institute co-operated through the alliance of individual membership.

Throughout its successful and beneficent career of almost half a century the Institute of Chemistry of Great Britain has had as its administrators a list of chemists which constitutes a roll of honor in British chemistry. The names of the presidents of the Institute from its establishment appear in the following table:

PRESIDENTS OF THE INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND

- 1877-80—Sir Edward Frankland, K.C.B., D.C.L., F.R.S.
- 1880-83—Sir Frederick Augustus Abel, Bart., K.C.B., G.C.V.O., D.C.L., F.R.S.
- 1883-88—William Odling, M.A., M.B., F.R.S.
- 1888-91—James Bell, C.B., D.Sc., Ph.D., F.R.S.
- 1891-94—Sir William Augustus Tilden, LL.D., D.Sc., F.R.S.
- 1894-97—William James Russell, Ph.D., F.R.S.
- 1897-00—Sir Thomas Stevenson, M.D., F.R.C.P.
- 1900-03—John Millan Thompson, LL.D., F.R.S.
- 1903-06—David Howard.

1906-09—Percy Faraday Frankland, F.R.S., Ph.D., F.R.S.
 1909-12—George Thomas Beilby, L.L.D., F.R.S.
 1912-15—Raphael Meldola, D.Sc., L.L.D., F.R.S.
 1915-18—James Johnston Dobbie, L.L.D., D.Sc., F.R.S.
 1818-21—Sir Herbert Jackson, F.I.C., F.C.S., F.R.S.
 1921—Alfred Chaston Chapman, F.I.C., F.C.S., F.R.M.S.

Functions of the Institute

At the twenty-fourth general meeting, on March 3, 1902, Prof. John M. Thompson, then elected president, showed that the Institute had been the means of binding together men who were engaged in the applications of chemistry. Until the foundation of the Institute the work of consulting, analytical and technological chemists had not been classed as a profession, but they had since acquired distinct professional standing. The Institute had undertaken the duty of seeing that the men who intended practicing the profession in its highest aspects were thoroughly trained, and of regulating that training. As a result of such training and of its examinations, it gave a guarantee to the public that its members were properly trained and competent men.

Prof. Meldola Changed His Attitude

Prof. Meldola in his first presidential address, on March 3, 1913, stated that he welcomed an opportunity of making confession of a change of view concerning the functions of the Institute. He happened to be a survivor from the period when the agitation in the chemical profession resulted in the organization of the Institute. At that time, in common with many of his contemporaries, he regarded the new movement, if not with actual disfavor, certainly with indifference.

It was held by many that there would be no scope for such a body, and that no justification could be found for the creation of another corporation of chemists. It was with especial pleasure, therefore, that he was able to make amends for that error of judgment and to declare that the more he had seen of the work of the Institute the more strongly had he become convinced that it had a public mission to fulfil precisely the same order of importance as that discharged by other bodies of professional men who served the community in various capacities.

The applications of chemistry in every field of human activity had steadily increased, and the importance of the profession to the public welfare had become more and more recognized. If the profession had not secured that full measure of public recognition to which it was entitled, Fellows and Associates should bear in mind that in their country all scientific affairs moved but slowly.

The unscientific atmosphere in which the average Englishman lived and moved was responsible for the apathy towards science which was a national characteristic. In this respect chemists were no worse off than the practitioners in other departments of science; in some respects, perhaps, they were better off, because the final outcome of their work could very frequently be expressed in that tangibly practical form which was capable of being gauged by the narrow standard of

immediate and obvious utility. The consolidation and the elevation of the profession lay in their own hands, and the status which the chemical practitioner should occupy in the public estimation was bound to become more and more determined in the future by the standards of efficiency and of conduct set up by the Fellows and Associates.

Some Comparisons

Comparison of present conditions in America with those prevailing in England fifty years ago as regards the status of education in applied science and in chemistry particularly, indicates that the forces impelling economic organization of chemically trained men are not entirely the same in each era.

In the former era the relative primitive status of chemical science, the inferior state of scientific education and the incompetency among the practitioners of chemistry, disclosed especially by the legislative imposition of responsibilities, made necessary the establishment of an organization to standardize educational methods, to inculcate professional standards, to promulgate qualifications to eliminate charlatry and to enforce public confidence in and respect for the professional status of the chemist.

Antagonism on the part of the Chemical Society to such an organization, to say nothing of the attitude of the Pharmaceutical Society of Great Britain in refusal to recognize any other class of chemist but the apothecary and in resort to law to deny to the new organization the use of the term "chemist" in its corporate name, indicate in the latter a condition practically non-existent in America and in the former a perennial state of conservatism, an intolerance that makes a fetish of organization, whose exponents magnify the machine and deprecate, regardless of the performance of an essential service, any progressive movement not originating with the element in control.

The pedagogical and technical conditions in England that fifty years ago demanded correction and found it in the initiative of a new economic organization, do not exist today in America, but the mental attitude toward disturbing innovations has the pertinacity characteristic of an attribute of human nature.

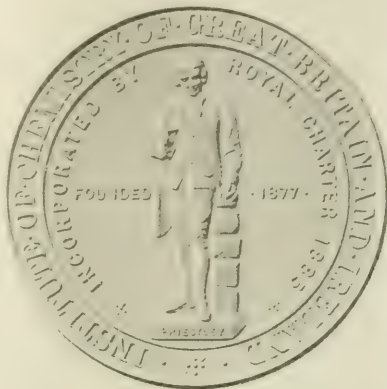
The pedagogical and technical conditions in England that fifty years ago demanded correction and found it in the initiative of a new economic organization, do not exist today in America, but the mental attitude toward disturbing innovations has the pertinacity characteristic of an attribute of human nature.

An Analogue

We have in the recurrence today in America of a situation of fifty years ago in England, the analogue of that system of political administration which built apparently effectively, until ultimately destroyed by the increasing concentration of its by-products, on the principle of all for one and one for all, the "one" being the machinery of organization.

The American chemist is an individualist and resents, when he has the opportunity and incentive of expression, the bureaucratic assumption of men who would do his thinking for him.

Over against the Teutonic idea is the principle of democracy of all for each and each for all, which is the basis of every professional organization that seeks in segregation a worthier service by demanding character and competence of its members.



Great Seal of the Institute of Chemistry of Great Britain and Ireland

Instinct and Its Expression in Social Activity

The gregarious instinct of man will be satisfied. Where conditions discourage its fullest, freest and most effective expression resort will be had to procedures initially *sub rosa* but which in time receive the open approval and encouragement of the system. Where among professional men will you find organized and growing, secret societies designed for class distinctions among the practitioners of the profession? Not among physicians, mining engineers, plumbers, lawyers, mechanical engineers, veterinarians, accountants, civil engineers, dentists, teachers, electrical engineers, nurses, clergymen or architects. We do find, however, a growth of secret organizations among chemists.

Many chemists as Greek letter fraternity men in their student days and as present members of fraternal organizations do not decry their virtues; but the great body of American chemists resent the substitution of this sop to consanguinity for a professional organization of chemists.

There are many broad-minded men who condemn, while retaining affection for their progenitors and managers, secret association and activities among the members of a great profession. The procedure is repugnant to ways of thinking in a democracy consecrated to equality of opportunity.

They deplore their recognition by the embracing organization of their class, but admit that the projection into the industrial relations of maturity of the partisanship and prejudices of youth is but the expression of the need of an economic organization among chemists, sanctified by friendship and rational helpfulness of a character that comports with the conditions of the time, but which violates not the instincts of freedom, capacity and ambition, which demand a fair field and no favor.

Open covenants openly arrived at will be the heart of the American Institute of Chemistry and with no secret diplomacy—with none of the secret machinations of questionable organizations which are as logical an outgrowth of the "system" as any projection of a government that expresses not the wishes nor satisfies the needs of the governed.

Broad-minded chemists condemn not so much the secret institution *per se* that functions as an Intelligence Division, as the conditions and the state of mind that encourage their growth and recognition as professional organizations within a great society. Cliques and coteries breed cabals which dissolve and disappear in the solvent of publicity.

An English Suggestion—Examinations, etc.

G. S. W. Marlow, assistant registrar and secretary of the Institute of Chemistry of Great Britain and Ireland, suggests that the American economic organization of chemists be called the American Institute of Chemists rather than the American Institute of Chemistry. The progenitors of the English organization were denied the use of the term "chemist" by the fact that pharmacists, in a time when the practice of chemistry was embraced in his activities, already had received exclusive legal sanction for the use of the term, which never has been relinquished for the more appropriate and rational special descriptive, "pharmacist."

We do not know that in this country the assumption of the title of chemist by the pharmacist is extending, but the fact that it is resorted to by many warrants such restriction in its use as would be a logical consideration for an economic organization of chemists. Whether the term "chemistry" or "chemists" is included in the

corporate title would be for the action of that group of men who in an organized way have investigated and confirmed the aspiration and need of chemists for an economic organization.

Scientific and educational progress and America's vaunted attainments in these fields impart here a different aspect to the subject of examinations for certification which is a prominent function of the English organization. Academic education and practical experience doubtless would be qualifications determinative of membership with such measure of certification as the governing body may ascertain as desirable or needed.

A Trite Analogy

Just as Great Britain is far in advance of America in the organized cultivation of the professional status of the chemist, so is America equally in advance of Great Britain in the similar cultivation of the economic interests of the chemical engineer. An attempt in 1880 to organize in London a society of chemical engineers came to naught because of the limited prospective membership. The idea, however, developed into the Society of Chemical Industry, founded in 1881, which recently organized a subsidiary Chemical Engineering Division.

The requirements of chemical manufacture have developed a character embodying skill in design and operation of plant and equipment, qualities possessed neither by the chemist alone, nor by the engineer alone. To function as a registration and coordination center for chemical engineers, a strongly supported plan, not to supplant the Chemical Engineering Division of the Society of Chemical Industry, but to exist as a separate but allied organization with distinct functions, now is approaching realization. What more fitting precedent can one present for the organization of the American Institute of Chemistry?

A Trend of Chemical Organization

The growth of chemical manufacture from 754 establishments in 1914 with products valued at \$200,-195,800 to 1,374 establishments in 1919, with products valued at \$694,643,000, an increase in value of 274 per cent., indicates not only the employment of a rapidly increasing number of chemically trained men, but a growing geographical distribution of the industry.

With the growing recognition of the importance of the chemist in our industrial system, come responsibilities of citizenship commensurate with his responsibilities in industry and which he can not shirk if he is to fulfill the obligations that society expects of its educated men.

Integration of organization and the concentration of control at a place remote and in men bent primarily on maintenance of organization and secondarily, if at all, in the intensive cultivation of the resources of distant states, will compel a decentralization of initiative and authority into bodies organized on state lines whereby will be possible the organized enterprise of the chemist as a citizen and the chemist as an industrial factor.

Thus can the industrial chemist, representing the chemical and allied industries of his respective state, align himself not only with other organized state activities in education, finance, production, transportation and trade, but with local government in all matters of industrial progress.

The success of the New Jersey Chemical Society is a precedent and a pattern for public spirited chemists everywhere to share their favor by the development of a state consciousness in organization designed to fulfill their obligation to society and, incidentally, to develop their own potentialities.

Present Status of American Oil Shale Development

By M. J. Gavin, H. H. Hill and W. E. Perdew

Bureau of Mines



THE destructive distillation of oil shale, or bituminous shale, in Scotland was first practiced on a commercial scale about 1852. Since then it has become an established industry there, the output of shale increasing gradually from 2,350 long tons in 1871 to 3,117,658 long tons in 1917. Since 1917 production of shale has decreased slightly. The distillation of bituminous shale has been a commercial industry in France since about 1850, although the amount of oil produced

has been much less than that produced in Scotland, and since 1900 the amount of shale retorted has been gradually decreasing.

At present (March, 1921), there are no shale-oil operations in this country that have reached commercial production, although there is a great deal of activity, particularly in the States of Colorado, Utah, Montana, Nevada and California, where there are large and easily accessible deposits of rich shale and some shale oil has been and is being produced. Other parts of the country also contain large deposits of bituminous shale. Several small plants have been completed and are operating from time to time, and others are under construction near DeBeque, Colo., one plant is under construction and one operating near Watson, Utah, besides two small plants near Elko, Nev., one near Dillon, Mont., and one in California. In addition, several experimental and demonstration plants have been erected in the large cities contiguous to the shale fields. A few plants are also being constructed in some of the eastern shale districts. To date none of these plants have operated under conditions that could be considered commercial, nor have they produced more than small quantities of oil during intermittent or short runs.

Properties of Oil Shale

Oil shale occurs in beds or strata ranging in thickness from a few inches to several feet, and its yield of oil ranges from practically nothing to 90 gallons or more a ton. Usually the oil does not exist as such in the shale, but is produced by the destructive distillation of complex organic compounds in the shale. These compounds are probably of vegetable origin. Destructive distillation, i. e., heating in the absence of air, decomposes this organic matter and yields hydrocarbon oils and permanent gases. Oil shale also contains varying quantities of nitrogenous compounds which under the

action of heat decompose into ammonia and other nitrogen bases, including pyridines and pyrrols.

Tests show that in this country layers of shale, mostly, however, too thin to mine commercially, can be found that will yield up to 90 gallons of oil a ton, and that there are extensive deposits of shale several feet thick, at least one being reported at 25 or 30 feet, that will yield, according to small-scale tests, at least 35 gallons of oil to the ton. It must be understood, however, that the quantity and quality of oil that can be obtained from a given shale will depend to a considerable extent on the methods used in obtaining the oil; the types of retort, rate of heating, removal of vapors, etc.

It also is difficult to get a small sample that truly represents a workable deposit. In Scotland testing methods have been worked out for Scotch shales which give results comparable with those obtained in commercial plants in so far as quantity of oil and ammonia recovered is concerned. If proper care is taken in sampling, such tests may be expected to furnish valuable information relative to yields of oil and ammonia.

The ash content of these American oil shales that may be considered of commercial importance ranges from 45-80 per cent., the average being about 60 per cent. Such a high proportion of ash renders it improbable that shale can be burned directly as a fuel. The heating value of a 42-gallon shale is about 4,400 B.t.u. per pound; that of the spent shale from this quality of material is about 1,100 B.t.u. per pound.

Status of Petroleum Industry

Although the production of crude petroleum in the United States has shown an appreciable gain each year, this gain has not been as large as the growth of the demand for petroleum products. Because of the large increase in the number of automobiles, trucks and tractors in this country, the demand for gasoline has become so great that the present domestic output of crude oil is not sufficient to satisfy the demand for gasoline of high volatility. During and after the war there was a marked increase in the demand for petroleum and its products, but just at present the supply exceeds the demand; this undoubtedly is only a temporary situation, however.

It is estimated by the U. S. Geological Survey that the curve of crude oil production will reach its peak within a few years, and then the country will have to look more and more to other sources for its hydrocarbon oils. It is entirely possible that foreign oil fields, not extensively exploited as yet, will supply the deficit caused by declining production and increasing consumption in the United States for a time. If and when foreign oils can not be obtained in sufficient quantities and at reasonable prices, we can turn to our oil shales for our supply of hydrocarbon oil when economic conditions for their development become possible. The enormous quantities of oil shales in the Rocky Mountain States can be made to yield hydrocarbon oils to a much greater extent than we can hope to obtain from our oil wells.

Our oil shales thus constitute a tremendous potential reserve. While oil readily can be obtained from these

shales, it has not been demonstrated in actual commercial practice whether it can be produced with profit under the conditions obtaining in the United States today.

A distinction must be made between the possibilities of local commercial developments under most favorable local conditions and the development of the industry on a sufficiently large scale to supplant in large part the petroleum industry. The latter is obviously many years ahead and must necessarily be the outgrowth of local industries started under rather exceptionally favorable conditions.

The question at the time is when and where such local industries can be started. There are to be considered, therefore, the broad questions of technique of mining and retorting shales and the refining of shale oils, as well as the economic considerations of costs and marketing of products. Much remains to be done in the technique of the industry, as it has not been established that the Scotch practice can be adopted *in toto* or that it is the best for American conditions. Still more remains to be done in establishing reliable cost data and value of products and possible by-products.

Mining and Crushing

A brief description of the methods used in Scotland will give an idea of the problems connected with obtaining and refining shale oil.

The Scotch shales are mined underground and the methods used are much like those of coal mining in this country. The roof is supported with pillars and usually about 25 per cent. of the shale is left underground in mined-out workings. An average of about $4\frac{1}{2}$ short tons of shale a day is produced per man working at the face. The shale is carried to the surface and transferred to breakers, consisting of two large, toothed rolls, where it is broken into pieces not larger than six inches square, and it is then transferred by means of tramways to the hoppers at the tops of the retorts.

Retorting

Each hopper, which is closed at the top with a lid or cover about eighteen inches in diameter, holds several hours' supply of broken shale. Moist sand is used to make a seal around the rim of the cover. The retorts are vertical and tapered, being about two feet in diameter at the top and three feet at the bottom. The shale feeds by gravity, and the taper aids the free downward movement of the shale. The upper part of the retort is a one-piece iron casting that averages about 12 feet high. It is in this part that the bulk of the oil distills. The vapors and permanent gases are removed under slight suction through a pipe that forms a part of the top of the casting. The lower part of the retort is built of one tier of specially shaped fire-brick, and averages about 18 feet high. In this part the shale is brought to its maximum temperature, about 1,700 to 1,800° F. Here most of the ammonia and water gas is formed, through the action of steam on the red-hot carbon and nitrogenous material remaining in the shale.

The shale is discharged from the retort into a sealed hopper that holds several hours' output of spent shale. Differences in the mechanical devices for continuously discharging the spent shale are important features that distinguish the different types of these retorts. Exhaust steam, about 750-1,000 pounds of steam to 2,240 pounds of shale, is admitted into the hopper holding the hot spent shale. This steam serves (1) to cool the shale in the bottom of the retort, (2) to carry heat from the spent shale into the retort, (3) to form water gas from

the fixed carbon, (4) to form ammonia by reacting with the nitrogen in the shale, (5) to sweep the oil vapors out of the retort, and (6) to effect a better transfer of heat from the walls of the retort to the center of the charge.

Four retorts are usually set together in a common furnace, and 16 of these units of four constitute a bench, which is two retorts wide and 32 long. The retorts are heated by permanent gases resulting from the destructive distillation of the shales, supplemented when necessary with coal producer gas. Experience in Scotland has shown that a Scotch shale yielding 25 imperial gallons (27 U. S. gallons per short ton) or more of oil per long ton of shale, will also yield enough fixed gases to heat the retorts. When the permanent gases from the retorts are insufficient for heating, producer gas is manufactured and used. The average capacity per day at the present time in Scotland is about 4 long tons ($4\frac{1}{2}$ short tons) per retort. In Scotland no use has ever been found for the spent shale, and it receives no treatment after being discharged from the hoppers under the retorts, but is dumped in huge heaps, called spent-shale "binges." The disposal of these great quantities of spent shale presents considerable practical difficulties and items of expense connected with the industry.

Separation of Products

The oil vapors, gases and steam from the retort pass into a common header and thence through air-cooled, vertical condensers. The oil and water vapors from the condensers run into separators, where the oil is separated from the ammonia water. The non-condensable gases are passed through scrubbers in order to remove the light oils and ammonia and are then used as fuel for heating the retorts. This gas with the gases from the oil stills constitutes a large percentage of the total fuel used at the plant.

After being separated from the ammonia water, the crude shale oil is transferred to the crude stills, where it is separated into various fractions by distillation. The scrubber oils are also distilled and the light oils thus obtained are added to the corresponding products from the distillation of the crude shale oil.

The refining of shale oil is much like that of petroleum, although the operations are more complex and more expensive. Shale oil differs from crude petroleum in containing certain organic compounds that have a particularly bad odor, tend to form gummy deposits, and must be removed before the product is marketable. Also, shale oil is more highly unsaturated than petroleum and hence requires more careful refining. The removal of unsaturated products and compounds having a bad odor necessitates several distillations and acid and alkali treatments, which increase the refining costs and losses. The average refining loss for shale oil in Scotland is about 25 per cent., as compared to about 7 per cent. in completely refining petroleum, in the United States.

The ammonia water obtained from the scrubber and separators is distilled and the ammonia obtained is passed into sulphuric acid to form ammonium sulphate.

Yield of Products

The shale now being retorted in Scotland yields on the average about 24.5 U. S. gallons of crude oil and about 35.7 pounds of ammonium sulphate per short ton. The yield of gas per short ton of shale retorted varies somewhat, but on the average is about 9,800 cubic feet; its heating value is about 240 B.t.u. per cubic foot.

The products obtained by refining the crude shale oil

are motor gasoline, illuminating oils, gas and fuel oils, lubricating oils, paraffin wax, and coke. The yield of these different products varies and depends to a certain degree both on the nature of the shale and on the conditions of retorting and refining. As a rule, three grades of lubricating oil are made, none of which is suitable for steam cylinders, internal combustion engines, or heavy duty bearings.

Success of the Industry in Scotland

All shale-oil plants in Scotland have not been a commercial success. In 1871 there were 51 companies engaged in the industry while at present there is practically only one, the five largest companies having consolidated in 1920. The successful companies have been those that, efficiently organized, have been able to employ the best technical skill, utilize labor-saving devices, and operate on a large scale. The industry has been favored by several factors, such as relatively low cost of labor, large yields of ammonium sulphate, high price of competing petroleum products, and situation in a densely populated industrial region where supplies and a market were close at hand.

From 1871 to 1916 the production of shale oil increased from 593,310 barrels to 1,969,000 barrels, whereas the production of ammonium sulphate in the same period rose from 2,350 to 59,400 tons. This indicates that increasing effort has been directed toward the recovery of ammonium sulphate. Undoubtedly, the increased recovery of ammonium sulphate has been a large factor in the success of the industry in Scotland.

Present Status of Oil Shale Industry in the United States

Up to the present time more than 150 companies have been organized for the purpose of developing or selling stock in oil-shale enterprises. Some of these are apparently essentially stock-selling organizations and are not likely to be especially helpful in developing the industry; others are really interested in making the industry a success and have been organized on a firm basis. Some of them have spent considerable time and money

on experimental work with the aim of developing retorting processes other than the Scottish that will be satisfactory for American shales.

About 60 processes for retorting oil shales in this country have come to the attention of the Bureau of Mines. These processes are in various stages of development, ranging from those that are still only in the minds of the inventors to the various processes successful in Scotland which are also expected by some to be equally successful in treating American shales. In some of the processes so far proposed the retorts are vertical, some of them being modifications of the retorts used with success in Scotland. At other plants, horizontal retorts with conveyors have been installed. A Pumpherston retort, of the type extensively used in Scotland, has been erected by one company, but it has not been given a thorough test as yet.

None of the different retorts in this country have yet been tried on a commercial scale. Probably the nature of the shale and the number and quality of products desired from both the shale and the oil will govern largely the selection of retort.

It may be that the retort which will be most successful with many American shales will neglect to some extent the recovery of ammonium sulphate, and by a large daily capacity will produce oil enough to more than compensate for the loss of ammonia. The American shales are somewhat richer in oil, and in nitrogen content compare favorably with Scotch shales. However, it is possible that best commercial results may be obtained by sacrificing complete extraction of oil and ammonium sulphate for increased capacity. The work of the Bureau of

Mines indicates that the nitrogen content of Colorado, Wyoming and Utah shales varies more or less directly with the oil yield, whereas the reverse holds for Scotch shales.

Location of Plants

The chief factors to be considered in determining the feasibility of a shale proposition and in choosing a site for a shale plant are as follows: Quality and quantity of shale; proximity to shale beds; mining conditions of



Shale Oil Plant of Monarch Shale Oil Company (Ginet Process) Located Thirteen Miles North of De Beque, Garfield County, Colorado. Continuous Operating Test, April 19-20, 1921. Produced Three Barrels of Oil Per Hour, or Seventy-two Barrels Per Day.

shale deposit; water supply; facilities for disposing of spent shale; transportation facilities for the products; labor supply; labor housing; and market conditions.

Transportation must be given serious consideration; provision be made for bringing in the machinery, supplies, and equipment, some of which is very cumbersome, and for removing the crude shale oil or the refined products to the market.

A plentiful supply of water is absolutely necessary. If possible the plant should be situated so that the spent shale can be easily removed by gravity.

At present the spent shale is a necessary nuisance, and its removal involves considerable expense. Extended efforts have failed to find a satisfactory use for it in Scotland. Small quantities have been tried in road and brick making in Scotland without success. The Scotch plants are marked by enormous dumps of the spent shale.

Estimate of Costs

Reliable general estimates of the cost of oil-shale mining and treating cannot be made, as the costs depend so much on local and individual conditions, such as location, accessibility and character of shale beds, methods of mining, cost and supply of labor and distance to market. Also, as there are no shale plants working on a commercial scale in this country, it is impossible to estimate accurately the cost and depreciation rate of such plants.

Mining

Some few shale deposits at first may be mined with steam shovels. Such mining is much cheaper than underground work, but most of the deposits that can be mined to advantage in this way are in places more or less inaccessible at present. In estimates of general mining costs it will be best to consider mining as entirely underground. There may be some special cases where costs will be much lower than the average for this type of mining, due to exceptionally favorable local conditions.

Probably the cost of mining shale will be about that of mining coal in the same general locality. As shale is tougher than coal is, perhaps, more difficult to mine, but on the other hand, little attention need be paid to the proportion of fines made in blasting and for that reason more powder can be used. It is believed that with the present scale of wages, to mine, break or deliver shale to the retorts will cost \$1.50 to \$2.50 a ton.

According to R. D. George, State geologist of Colorado, in a statement at a hearing on oil shale before Assistant Secretary of the Interior Vogelsang, January 25, 1918, the average cost of mining coal in Colorado at that time was \$1.37 a ton. Undoubtedly this cost has creased since that time, with the general rise in cost of labor, materials, etc.

Retorting

The cost of retorting will depend not only on local conditions, but also on the type of retorts or the retorting process employed and the scale of operation. It is impossible to estimate such costs until plants have been running on a commercial scale long enough to give cost data on depreciation, repairs, replacements, etc. The pre-war cost of retorting in Scotland was about forty cents a ton, but to accept that figure, without modifications in making estimates of present charges is not justifiable, as labor and material costs, even in Scotland, are much higher than they were before the war.

Refining

The refining of shale oil will be more expensive than the equivalent refining of petroleum. There are so many different methods of obtaining refinery cost figures that a cost figure means little, if a statement is not made as to how it is obtained.

Until more is known regarding the properties of the oils produced from our American shales, and of the problems connected with their refining, it is not considered justifiable to assume that the cost of refining shale oil will be the same as the cost of refining petroleum in this country, or the refining of shale oil in Scotland. Emphasis should be drawn again to the fact that oils from different shales and those obtained by different retorts or conditions of retorting may have very different properties and call for different refining processes with different relative costs. Factors which have decided bearing on the costs of refining, aside from quality of the oil, are scale of operations and quality and quantity of products made.

Refining crude shale oil is one of the largest works in Scotland, manufacturing the following percentage of products, exclusive of plant depreciation and packing and shipment of products, costs approximately \$1 05 per barrel of 42 U. S. gallons. This figure is for 1919 and is not necessarily applicable to American conditions and American shale oils or Scotch practice at the present time. Products made are:

	%
Naphtha (including scrubber naphtha)	9.9 (450° end point)
Burning oil	24.7
Gas and fuel oil	24.4
Lubricating oil	6.6
Wax	9.5
Loss (including still coke 2%)	24.9
	100.0

Attention is called to the high refining loss and to the fact that the lubricating oils, by reason of their low viscosity, command a considerable lower price than lubricants made from petroleum.

It is obvious that considerable skill and experience will be needed to produce many different marketable products from shale oil and expensive equipment and trained men will be necessary for making lubricating oils and paraffin. Possibly those starting in the industry may plan on partly refining the oil and marketing only motor fuel, fuel oil and ammonium sulphate, and after they become familiar with handling the oil, put in equipment for making lubricating oils and wax.

In refining shale oil, conditions are somewhat different than in refining petroleum, as the gasoline content of the oil is relatively low and, in Scotland, the wax has furnished the most valuable product from the oil. Too much emphasis cannot be laid on the fact that the manufacture of good lubricating oils requires men of extensive training and experience, that the manufacture of lubricating oils from shale oil will demand a great deal of research and experimental work before it can be established as a successful industry, and that it may never be possible to make the more viscous grades of lubricants from shale oil.

Ammonium Sulphate

The cost of producing ammonium sulphate will depend on a number of variables. The method of retorting, nitrogen-content of the shale, cost of sulphuric acid, and transportation charges on this acid must be considered. In Scotland the pre-war cost of fixing ammonium sulphate was about 0.7 cents a pound, exclusive of interest on plant investment as well as of mining and

retorting costs. As the American shales generally contain lower percentages of nitrogen, and the other costs are higher, it is reasonable to believe that the cost of producing ammonium sulphate in this country will be higher than in Scotland.

By-Products

In Scotland little attention has been paid to possible by-products, since a ready market exists for the ordinary distillation products of shale and ammonium sulphate. The latter is the only by-product produced to any extent from the Scotch shales, but is extremely important in the success of the Scotch industry.

Little is known of the possibilities of by-products from American shales. There is a possibility that by-products may be obtained that will increase the sales value of the products from shale considerably more than could be expected from oil and ammonium sulphate alone. The by-products should be given serious study, involving questions of qualities, quantities, commercial methods of production and costs, and particularly market conditions of value and demand.

These questions should be most thoroughly studied from both the technical and economic phases before any possible by-products should be used in estimating values for a shale-oil plant. A by-product is what the name implies, i. e., something produced as a side issue from a main product, and by-products have generally been the outgrowth in the later stages of an industry firmly established upon its main products. In some industries the by-products have become the main products and the original main product, the by-product, but only after long and thorough research work and experimentation, coupled frequently with increased value of the by-products.

Marketing Shale-Oil Products

The difficulties that are likely to be encountered in marketing oil-shale products must be given consideration. The petroleum industry of this country, established for many years, has developed an extensive and efficient system of marketing its products. Before shale-oil products can become of commercial importance it may be necessary to carry on a campaign of education in order to convince the public that such products can be used with the same degree of satisfaction as those obtained from petroleum.

The marketer of petroleum products has a distinct advantage through the largest oil refineries being located either on the seaboard or near the marketing centers, whereas it seems that the shale-oil refineries will be located largely in the Rocky Mountain region.

Until the shale-oil industry has assumed large por-

portions it must depend upon local markets under the local competitive conditions that prevail during that period. At the present time the chief competition will be from products obtained from the oils of the Wyoming oil fields which marketed over 17,000,000 barrels of high-grade crude oil in 1920, selling at \$1.75 to \$3.10 a barrel at the well. The oil-shale plants in Scotland are located very favorably, for they are near the two largest cities of Scotland and compete with petroleum products that must be imported from the United States and other foreign countries.

Future Possibilities of the Industry

While the oil shales of this country can yield enormous quantities of oil, large amounts of money will have to be invested before the industry becomes of commercial importance. Estimates by various engineers of the cost of a complete retorting plant, handling 1,000 tons of shale a day, are between \$1,000,000 and \$5,000,000, and if the average shale treated yielded 42 gallons of oil a ton it would probably require at least 1,300 such plants operating 365

days a year to supply the volume of crude oil that was consumed in this country in 1920, and the shale mined daily would amount to approximately one-half the coal mined daily in this country. However, it is hardly to be expected that shale oil will be called upon to replace petroleum completely for a great many years. Although the Scotch industry has been existent for more than 50 years, the amount of shale oil produced in Scotland during the calendar year of 1920 was less than two days' average production of crude oil in the United States during the same year.

The oil-shale industry is not strictly comparable to the petroleum industry. Obtaining oil from shale is not comparable to obtaining crude oil by drilling. In drilling an oil well the element of chance has to be taken into consideration, but there is always the possibility of a large immediate reward on a relatively small investment. After oil has been struck the cost of transporting it to the refinery is in most cases relatively small, as there are systems of pipe lines throughout the oil fields.

In producing oil from shale the original cost of the shale in place is practically nothing at present. Estimating the supply of oil recoverable from a given tract involves little difficulty, for a few test holes and analyses can establish the thickness and the richness of the bed in a similar manner as the value and extent of a coal deposit is estimated.

It must be realized that the production of oil from oil shale is a large-scale manufacturing enterprise that involves the handling of large amounts of low-grade material. It is comparable in many respects to the extraction of gold or copper from low-grade ores. The



Inspection Point at Shale-Oil Plant of Monarch Shale Oil Company. Condensers at the Right.

original investment for equipment is heavy, the operating expenses high, the profit per ton probably small, and a large daily capacity and good management are essential for profits.

In this country the oil-shale industry can not be developed overnight and probably can not attain success until large sums of money have been spent in perfecting mining, retorting and refining methods. A company to be successful, whenever oil-shale operations become commercially feasible, must be able to employ the best technical, business and engineering skill available, be prepared to operate on a large scale, and be financially strong enough to wait several years for any large re-

turn on the money invested in founding the enterprise.

A large amount of credit will naturally be due those pioneering companies that will carry development work so far that whenever the petroleum industry fails to meet the demands for its products the oil-shale industry will be in a position to make up the deficit. It is unfortunate that a large number of the many companies organized to deal with oil shale are devoting their efforts to stock-selling rather than assisting in building a firm basis for the industry. Appeals to the cupidity of the ignorant involves often reactions harmful to sound industrial growth.

Expansion of Instruction Facilities in Chemistry

GROWTH of the chemical and allied industries and the increasing recognition of the importance of chemistry to modern civilization, have their reflection in the demand upon educational institutions for instruction in the fundamental science and art of chemistry.

Notable in the current expansion of instruction facilities in chemistry is the new \$1,500,000 chemical laboratory of Cornell University, Ithica, N. Y., which is expected to be completed within a year.

estimated will yield an annual income of approximately \$1,000,000 for the maintenance of the university.

Yale is to begin construction this fall of a \$3,000,000 chemical laboratory which will be one of the largest and most completely equipped in existence and is planned for the purpose of making Yale one of the great chemistry centers of the world.

The building is to cost \$2,000,000, and at least \$1,000,000 more is to be expended in equipment. The



New Chemical Laboratory Building, Yale University, Delano & Aldrich, New York, Architects.

Dr. K. G. Matheson, president of the Georgia School of Technology, announces that the sum of \$1,222,857 has been contributed toward the fund of \$5,000,000 which the institution has undertaken to raise for permanent buildings and equipment.

About \$400,000 of the \$500,000 appropriated for building purposes at the University of Iowa, Iowa City, Ia., by the last general assembly is to be expended for the erection of the first units of a new chemistry building. When completed the building will cost \$1,000,000.

The Louisiana State University will receive \$7,500,000 for new buildings and equipment as a result of the action of the Constitution Convention which has just adjourned, this sum having been set apart for this purpose from funds accruing from the newly established severance tax on oil and other natural resources.

Plans are now being made for the erection of the new buildings on a 2,000-acre tract near Baton Rouge, Olmstead Brothers, of Brooklyn, Mass., having been secured as landscape architects. The new constitution, now in effect, also provides for a half-mill tax, which it is

enterprise will be financed from the \$18,000,000 gift of the late John W. Sterling. Delano & Aldrich of New York are the architects, and the building contract has been let to Thompson Starrett Company of New York. Its site will be on the Hillhouse plot.

Yale's expansion in the field of chemistry has been stressed in the last several years by a strengthening of the faculty and enlargement of equipment, in order to put the institution abreast of modern alliance of chemistry with invention, discovery and industry.

Prof. Treat B. Johnson, whose chair is organic chemistry, with special reference to modern industry, plans to place Yale in touch with unfolding countries, such as China, and to educate students especially to develop the resources of such lands. It is also planned to make a specialty of receiving students from foreign lands, who shall take their knowledge back home and direct it into the current of international commerce.

All these steps are in accordance with the purpose of President Angell to attract ambitious students who are anxious to study under men famous in specialized lines.

Chemical Manufacture and Tariff Legislation

Brief of the Manufacturing Chemists' Association Before the Senate Committee on Finance.

By Henry Howard

Of the Grasselli Chemical Co., Chairman, Executive Committee.

IT IS hardly necessary to remind the Senate of the tremendous importance that a highly developed chemical industry bears to the prosperity of any country. Its relative development is perhaps the best index of the progress of civilization in a country. Its high development always is accompanied by utilization of waste products and building up and creation of new products and new industries that in many cases never existed before, all of which in the aggregate adds enormously to the wealth, prosperity and happiness of the people. But we must not forget that development of this sort is predicated on continued systematic research carried out at great expense by the most highly-trained experts obtainable. This sort of work is possible only when the industry is in a prosperous condition, because it requires generally a number of years before any adequate cash return is realized on the large sums spent in chemical research and development work.

The importance of a large well-developed industry in acids, alkalis and coal tar dyes in any preparedness program is so familiar today at the end of the war that reiteration would be unnecessary.

Increased Rates Needed

In this brief we shall deal only with the features of the tariff which have general application to all our members. We wish particularly to call your attention to the importance of a proper differential between the rates on raw materials and the rates on products made therefrom; in some instances this apparently has been overlooked in H.R. 7456. If we might suggest, this could be referred to your committee's chemical expert. Importance of a Proper Differential

When our members filed their briefs with the Ways and Means Committee on January 6, 1921, they asked for the lowest rates which they felt would prove adequate. Subsequent events have proved, however, that in a number of instances they were entirely too low. Specific instances supported by facts and figures have been furnished you.

Dyes Industry

Without entering into arguments regarding protection for the coal tar chemical and dye industries—our newest American chemical development—we urge the fostering of their growth through proper control of foreign competition, as well as by tariff legislation.

Tariff Rates

The rates must be sufficient to protect American labor. This is fundamental, and is especially urgent at the present time, because we are not only confronted with the problems of protection for new industries, developed as a result of the war, but also with the task of protecting adequately our highly paid American labor in established industries from ruinous competition with cheap European labor resulting from the combination of the vast armies of unemployed European labor and the badly depreciated European currency.

The problem in its present form is really not alone one of depreciated foreign currency or of low foreign exchange—but of low wages.

I wish to quote a prediction we made in our *Brief to the Ways and Means Committee of the House on January 6 last, which has already come true.

"Germany currency and German exchange are at about one-eighteenth of their old par value. If German wages were now eighteen times as high in paper marks as they were before the war in gold marks, the low exchange rate and depreciated currency would present little concern for us. But German wages have risen on the average only seven or eight-fold in their currency, according to information sent the last of November, 1920, to the National Industrial Conference Board by its investigator in Germany, and so, when the barriers shall be down again and trade resumed, if Germany can send her goods to America at the old prices in dollars and get eighteen times as much for them in paper marks as formerly, and produce these goods by paying only seven to eight times as much in wages, it is manifest that what already was cheap German labor before the war, has become, roughly, twice as cheap now."

That the foregoing prediction has been literally fulfilled is evidenced by our idle workmen, factories shut down, and German goods offered everywhere for sale.

Tariff Rates Should Not Be Prohibitive

Tariff rates should not be placed so high that they will prohibit importation. The tariff should act in general both as an adequate protection to American labor and industry and as a source of revenue to the Government. There are, of course, important exceptions to this rule, as, for instance, when public policy demands the upbuilding of an infant industry such as the dye industry, the reasons for which are too well known to you to need repetition.

We do not believe there can be any intelligent rates unless they are based on American valuation, for reasons already presented to you in our brief and testimony on this subject.†

If, however, American valuation is not adopted it is of course perfectly obvious that all the ad valorem rates in H.R. 7456 are entirely inadequate.

Medicinal and Miscellaneous Technical Chemicals

The importance of medicinal and miscellaneous technical chemicals is strongly emphasized as being a very important branch of the chemical industry, viewed from the standpoint of the welfare of the nation.

This industry embodies a large, varied and continuous production of every and all kinds of medicinal supplies. The industry is of vital importance to the health of the nation at all times. There must be a complete and comprehensive supply at all times of the normal medicinal requirements, and particularly in time of epidemic, plague and catastrophe such as the country witnessed from time to time. It is plain that the maintenance of this industry should be fostered to the utmost within the borders of the United States.

The industry is of great necessity to the country in time of emergency and we urge that due consideration be accorded to its needs.

*CHEMICAL AGE, January 1921, p. 17.
†See "Import Valuation of Basic Chemicals," by Henry Howard,
CHEMICAL AGE, March 1921, p. 83.

Type of Rate Desired

We believe that wherever it is possible specific rates should be used in place of ad valorem, thereby greatly simplifying the administration of the act. It is important, however, in many cases to provide two or more specific rates to cover different qualities, for instance, Paragraph 73 of the 1909 act provided: Sulphide of soda, containing not more than 35 per centum of sulphide of soda, $\frac{3}{8}$ of 1 cent per pound; sulphide of soda concentrated or containing more than 35 per centum of sulphide of soda, $\frac{1}{4}$ of 1 cent per pound.

In the act of 1913 this dual classification was abandoned and a flat rate of $\frac{1}{4}$ of 1 cent per pound substituted, with the result that only the concentrated product, one pound of which was equal to two pounds of the crystals, was imported at a rate designed for the crystal or unconcentrated variety. This concrete instance is given as being typical of a great many and shows the advisability of providing two or more specific rates in all cases where it is possible to substitute a more concentrated or more valuable product for the one in common use at the time the tariff is written.

Without passing on the adequacy of the rates named we note with approval that this condition as to sulphide

of soda has been corrected in H.R. 7456, and we strongly urge that this principle be followed in every case where it is possible. In some cases better results are obtained by combining specific and ad valorem rates.

Since our brief of January 6th, submitted to the Ways and Means Committee, was drawn up, the conditions predicted at that time have actually come to pass. The depreciated foreign currency and the low labor scales abroad, and the ratio that obtains between them, have worked the unavoidable result. Today scores of chemical products are being imported at prices which make American competition impossible. Production here consequently has been curtailed or entirely suspended.

We would emphasize, too, that we are only at the inception of this import movement of chemicals. Conditions abroad, particularly in Germany, have retarded the inevitable struggle for chemical supremacy. We may expect, from now on, a continuous and systematic attack on the American chemical market. We have no hesitation in saying that the situation is worse than our fears anticipated in January last, and we pray your Committee to save the American chemical industry from a threatened disaster which cannot now be measured.

The State and the Recognition of Professional Status

By Augustus S. Downing

Assistant Commissioner and Director of Professional Education, New York State Department of Education.

IN the evolution of the social status of men trained to pursue an occupation, practice of which requires a degree and character of special knowledge and aptitude that differentiate them from craftsmen and give to their vocation the distinction of a profession, sooner or later comes the demand that the class consciousness shall have general recognition.

The course usually pursued is the inculcation of standards of fitness and conduct. This is initiated by forward-looking members of the class under the pressure of competition of those who do not measure up to the standards of qualification and character which general opinion deems should be recognized.

Dependence upon the State in furtherance of the aid of a natural process of segregation of the fittest takes the form of legislation that declares standards of qualifications and requires of those who would assume them such evidence of capacity as may satisfy those responsible for the legislation creating State-recognition of the profession.

From time to time, men in the various occupations in life have become imbued with the same ideas that are now occupying the minds of chemists. Since 1895 the Board of Regents of the University of the State of New York has been charged with the responsibility of licensing men practicing the professions which have to do with questions relating to public health.

In 1908 optometrists, who have to deal with the correction of defective vision due to physical causes only, obtained legislation limiting the practice of optometry to licensed men.

As far back as 1896 the certified public accountants succeeded in having a law passed granting to those who could meet the educational requirements set by the Board of Regents a certificate known as a certified public accountant certificate.

In 1910 pharmacy came by law under the supervision of the Board of Regents.

In 1911 shorthand reporters had enacted a statute

similar to that governing the practice of accountancy.

In 1915 the general business law was amended requiring the registration and licensing of architects.

In 1920 a law was enacted for the licensing of professional engineers and land surveyors.

The initial steps bringing about these amendments always have been taken by leaders in these several occupations, recognizing all the time in their preparation of the bill to be introduced in the Legislature, that whenever any body of men engaged in any vocation in life knock at the entrance to the professions, that is, ask to have their vocation or occupation regarded as a professional one, they admit that certain educational qualifications and certain experience in the practice of the occupation shall be made a pre-requisite for licensing by the State, such licensing putting the State's stamp of approval of fitness on the man holding the license to practice his profession.

The Department of Education and the Board of Regents of the State of New York, as stated above, have not initiated such procedure on the part of any one of the professions now supervised by this Department. The law requiring the licensing of professional engineers covers chemical engineering. In making up the Board of Examiners under this law we were careful to choose a representative of the American Institute of Chemical Engineers in the person of Albert H. Hooker of Niagara Falls.

I desire to make clear the attitude of the State Department of Education in all of these matters. It is understood that there is no desire on the part of the Board of Regents to extend their power of supervision in any new field of activity, but that when a law has been enacted placing the administration thereof upon the Board of Regents, they have no option whatsoever in the matter except to accept such responsibility and to administer the law in the interests of the public and at the same time to the safeguarding of qualified members of the profession interested.



FIG. 10. A. Plant of E. A. Stevenson & Co., Maragon Manufacturers.

Coconut Oil Production and Refining

By Adolph W. Krebs

Superintendent, E. A. Stevenson & Co., Inc.

COCONUT oil is produced from the kernel of the coconut, which is the fruit of the coconut palm, *Cocos Nucifera*. The home of the coconut is in the East Indies, but thanks to the protective husk on the nut, it has spread all over the islands of the Indian Ocean and the South Seas. It grows in tropical climate, preferably at low altitudes and near the ocean shores. In fact the stem of the tree at times curves right out in the water from its base. The best fruit is produced between 12° South latitude and 15° North.

In tropical South America a different species is found, known as *Cocos Butyracea*. In sub-tropical climate the tree will grow but does not develop any nuts. The young tree starts to flower at an age of about 6-7 years. When 8-10 years it develops full-sized nuts. The full grown tree is about 50 feet high and will carry fruit until it is 60 years old. In a few cases, trees are known to have been 100 years old without losing their productive power. About 60 nuts are produced yearly per tree and about 9,000 nuts are required for one ton of oil. At present over 3 million acres are under cultivation, of which 750 thousand are in Ceylon and about the same area in the Philippines.*

Copra

Only the fully-ripened nut is used for oil production. It contains about 30-40 per cent. of fat and 50 per cent. of moisture. The dried kernel, which is called copra, generally contains 60 per cent. of fat and 8-10 per cent. of moisture. This drying makes possible the transport of copra without rotting. The copra is produced by splitting the nuts open and leaving the kernels to dry in the sun. In a dry climate a very good grade of copra is produced. To be independent of the sunshine, and also in order to shorten the time of drying, kiln-drying is resorted to. This, in most instances, is a very simple process.

The copra is spread out over a plain bamboo rack and a fire lighted underneath, but dried in this manner it always has a peculiar empyreumatic odor and produces an oil which is discolored by tar and proves refractory in the bleaching process. Both these methods have been practiced since early time, but are always followed by enormous waste. The best practice is to

bring the nuts, immediately after they have been picked up, into sheds, so as to protect them from the rain and sun. The husk is then removed while the fibre is in good condition.

The nuts are split open. The kernels are placed on bamboo hurdles arranged on small wagons, and these wagons are then drawn through a tunnel where they meet a current of hot air on the counter current principle. By this method a very clean copra is produced, with an oil content up to 74 per cent. and with only 4 per cent. of moisture. Such copra does not readily go rancid or get mouldy and yields a very fine oil, which is almost colorless.

The amount of copra produced is very large and still increasing. The export of copra is about 500,000 tons per year, of which about one-third comes from the Philippines. To picture the development of the coconut oil industry in the United States, the following figures serve:

Year	American Imports of Copra million pounds	Copra million pounds	Coconut Oil million pounds
1915	90½	63	66
1916	110	79	79
1917	207	356	281
1918	430	281	179
1919	259		
1920	167		

Oil Recovery

The oil was first recovered by the natives by pounding the kernels and then throwing them into boiling water, where the oil would rise to the top and could be skimmed off. Fresh nuts just opened were treated in this manner and a very good grade of oil resulted. The large bulk of coconut oil, however, is produced from copra, either at the place of origin or in the mills of United States and Europe, and almost exclusively by crushing and pressing. Separation from foreign matter, such as gravel and nails, done by simple screening and passing the copra over a magnet, is the initial treatment.

Breaking and Crushing

The breaking is done principally in the roller mills. These roller mills are generally arranged with three pairs of rollers mounted one above another in one frame, and on the top is a breaker. This breaker consists of a horizontal steel shaft to which is attached

*Presented at Atlantic City meeting, June 20th Institute of Maragon Manufacturers.

a number of curved claws about $1\frac{1}{4}$ inch apart, while on the inside of the feed hopper and on a level with this shaft, a set of steel pins is arranged projecting in between the claws.

By rotating the shaft the copra is broken down to about the size of a walnut. The rollers are all made of cast steel and only steel forms are used in order to get a hard casting. The two upper sets of rollers are grooved; the top set coarse and the second, finer. These grooves run on an angle with the roller axis, and as the speed of each roller in any pair is arranged so that one travels faster than the other, there is about 5-10 per cent. difference.

Three different actions are carried out at once, viz., (1) simple crushing, (2) cutting by the edges of the two rollers crossing each other, and (3) tearing, by one roller moving faster than the other.

These three actions are all necessary in order to destroy the tissue and open up the cells so that the oil will flow out. The third set of rollers is smooth. The length of the rollers in all three sets is the same, 24-30 inches, but the diameter increases from about 16 inches for the top set up to 26 inches for the smooth set. The surface speed is about 2 feet per second for the grooved rollers and about 6 feet for the smooth rollers. Each roller is positive driven by belts over pulleys at each end of the machine. The bearing of one roller in each set is adjustable and floating on a spring, in order to prevent destruction by any hard object which may enter the machine.

Cooking

From the roller mill the coarse ground meats are conveyed to the cooker where they are heated and tempered. The object of warming the meats is to make the oil flow more easily and also to coagulate some of the albumen. Incidentally color is taken up by the oil, as well as odoriferous matter. The cooking is an operation which requires considerable skill and experience. Upon its correct execution will depend the successful pressing. A charge cooked correctly may require only 700-800 pounds pressure, while by faulty manipulation of the cooker, a charge of exactly the same quality may require 5,000 pounds pressure.

The usefulness of cooking has been known from the earliest times, and was carried out in open basins over fire, but now steam-jacketed steel pans 4-5 feet in diameter and about 15 inches deep, are used, all fitted with mechanical agitators. Recently closed cookers have come into use with two pans arranged above each other. These cookers are automatically controlled; the size of the charge, the temperature, the time, can be fixed as required. Generally the finishing temperature for copra is 150° F.

Pressing

A large number of types and constructions of pressing equipment is used, but the screw and wedge presses have been almost entirely displaced by the hydraulic press. There are many different types of hydraulic presses, viz., open or closed types, cage presses, box presses, ring presses and the flat shelf press, which is used largely for linseed oil. In the very newest installations only one pressing is necessary, but generally a regrinding and pressing are resorted to.

About 63 per cent. of oil is recovered, according to the content of oil in the raw material. The cake contains about 7-10 per cent. of oil. The crude expressed oil is settled in large tanks and later filtered or treated straightway in a hydro-extractor. This oil represents what is termed "crude coconut oil." The free fatty acids vary within large limits, from less than 1 per cent. for the highest-grade copra to 7-8 per cent. or

even more for low-grade copra. The usual oil as received from the Philippines in this country contains about 5 per cent. Crude coconut oil is used by the soap manufacturer but for the last twenty years more and more oil is refined for edible purposes, for cooking oil and for margarine manufacture.

Oil Refining

The refining has three objects: the elimination of free fatty acids, the brightening up of color, and the removal of any odor and taste.

The free fatty acids are removed by treatment with caustic soda solution. The oil is heated up to the proper temperature and caustic soda is added slowly through a spraying device while an agitator is keeping the oil well mixed. When all the free fatty acids have been neutralized and the necessary excess of caustic soda added, the oil is seen to break. An emulsion is formed by the addition of caustic soda, but this emulsion coagulates when the full amount has been added, leaving the oil bright and clear, separating from the soap solution. The agitation is then stopped and the oil allowed to settle for about 8-10 hours. The clear oil is then separated from the soap-stock by means of a skimmer.

This oil which is called neutral oil is then treated to remove small traces of soap which have been kept in suspension. Various plants work this by different methods, but the result is the same.

Bleaching

Before the oil goes to the next treatment, the deodorization, all soap has to be removed and usually the oil is also bleached. This bleaching is effected by agitating the oil with a small amount of Fuller's earth or Filtchar. The bleaching earth is commonly known as "Fuller's Earth." It is a type of clay which is found in very fine grade in this country in Florida. It is only in the last few years that the American refiners have recognized domestic fuller's earth, which is known under the name of Floridin, as being suitable for oil refining. Large quantities of fuller's earth used to be imported from England, but already eight years ago England started importing Floridin for bleaching oils. The Filtchar is a vegetable carbon with high decolorizing properties.

Deodorizing

The object of the deodorizing process is as described by the name, the removal of odoriferous matter. The specific coconut oil smell is due to the presence of small amounts of certain essential oils which are volatile. By blowing super-heated steam through the oil by means of a perforated steam-coil or other distributing device in a closed tank, which at the top has a vapor outlet connecting to a condensing and vacuum installation, these substances are carried off. This steam is used at the rate of one ton and a half per hour for a deodorizer working with a four-ton charge. Six hours' treatment is about the average, the time varying somewhat with the different types of oil.

The oil upon cooling must be odorless and have a sweet neutral flavor. When this point is reached the oil is discharged into a cooler where it is cooled by water circulating through coils and by the exclusion of air. If any air comes in contact with the oil while it is at about 170° F. the flavor will be impaired. Now the oil is again filtered and sometimes bleached and is then ready for consumption.

Color Standards and Free Acidity

The practice in this country has required the color of refined coconut oil to be no deeper than 12 yellow and 2 red measured in the Lovibond tintometer units, and with $5\frac{1}{4}$ -inch oil layer, but in the last year or two oil

considerably lighter in color than this has been put on the market. The color is not necessarily an index as to quality. The first consideration in refined oil is the flavor. By proper handling a white margarin can be made from oil testing 15 yellow and 2.5 red.

The free fatty acids now are generally guaranteed to be less than 0.1 per cent., but this standard is fixed more as a selling point by certain refiners than being a necessary requirement by the margarin manufacturer.

Good margarin can very well be made with an oil containing as much as 0.25 per cent. of free fatty acids.

Coconut oil has a melting point of 76-78° F. For margarin use the coconut oil is mixed with peanut oil, which gives a mixture of a still lower melting point. For summer trade the nut margarin made from coconut oil and peanut oil has not a sufficiently high melting point, and in the last few years hydrogenated coconut oil has been in favor.

Hydrogenation

Hydrogenation is the process by which hydrogen is directly added to the glycerides of unsaturated fatty acids. It is not to be understood as an absorption similar to ammonia in water. A true chemical reaction is accomplished. One molecule of oleic acid, $C_{18}H_{36}O_2$, with a melting point of 57° F., by combination with two atoms of hydrogen is converted into stearic acid melting at 157° F.; but the combined glycerides also are acted on, olein being converted into stearin. If hydrogen and coconut oil were mixed together in a closed steel tank, and the temperature and pressure regulated to any desired point, no reaction would take place, but thanks to the work of the two French chemists, Sabatier and Senderns, published in the year 1900, the activating or catalytic properties of finely divided metals on hydrogen were made clear.

They stated, however, that vapor alone of the unsaturated bodies to be hydrogenated must come in contact with the catalytic material. It has since been found that fatty acid in a liquid state, as well as pure glycerides and oil, were hydrogenated in the presence of finely divided metal catalysts. A large number of patents have been taken out within the last decade, describing all kinds of apparatus to insure the quickest accomplishment of the reaction. A very thorough mixing of the gas and oil is essential. In a general way there are two principles, either circulating the hydrogen through the oil or the oil through the hydrogen atmosphere in a closed tank.

With reference to the catalyst, nickel, cobalt, iron and copper all can be made active, as well as platinum and palladium. Nickel is the only one in practical use in this country. Palladium is used in Europe by only one concern. Cobalt, iron and copper are too weak in their action. Platinum is very active but easily poisoned. The hydrogenation with nickel catalyst has to be carried out at a temperature around 300° F., although some reaction takes place at 240° F. With palladium, however, ordinary temperature, 70° F. only is necessary. This of course is an advantage, but the very high cost of this metal restricts its use. The catalytic action is a surface action, and to utilize economically this action, the metal has to be very finely divided, which gives it a large surface.

Preparation of the Catalyst

Two different principles are used. Precipitation of nickel carbonate or hydroxide, which upon heating, yields nickel oxide, which is reduced in a dry state in a current of hydrogen to metallic nickel.

The second principle is to prepare organic salts, such as nickel formate or lactate, which are mixed with oils

and then the mixture is heated, the nickel is set free in a finely divided state. When using a catalyst of the first type, usually an inert substance such as Keiselguhr is employed as a carrier. The technical process is in general as follows:

The hydrogenating vessel is charged with oil to its specified capacity, which varies from one barrel to 30 barrels, and the oil is pre-heated to the required temperature; the catalyst, suspended in a small amount of oil, then is pumped in. The hydrogen valve is then opened and with the circulating or agitating device operating, the absorption takes place. The progress of the process is watched by testing samples for the iodine value.

After the hydrogenation has been carried out to the desired point, the oil is run through a filter press to separate it from the catalyst. This catalyst is used over and over a number of times, depending on the quality of the oil. When oil is intended for edible purposes, it is neutralized before hydrogenation and carefully dried and filtered. Coconut oil contains only a very small amount of unsaturated fatty acids. The oleic acid-content is less than 5 per cent.

The iodine value is an indication of the quantity of unsaturated fatty acid, and varies considerably for the different oils; for instance, the iodine value for cottonseed oil is about 110 per cent.; for peanut oil about 95 per cent., but for coconut oil only between 8 and 9 per cent. In the process of hydrogenation the iodine value is reduced, in the case of coconut oil to below 1 per cent, which raises the melting point from 76° up to and over 90° F.

National Association of Chemical Salesmen

At the Chemists' Club, New York, on August 1, prominent representatives of the sales organizations of chemical manufacturing concerns took initial steps to effect the formation of a national society of men identified with the distribution of chemical products. Among those present were:

Charles F. Abbott and Justin R. Widdell, National Aniline & Chemical Co.
E. J. Barber, The Barrett Co.
John A. Chew, Warren Chemical Co.
George H. Draper, E. Fougere & Co.
J. F. Hollywood, Marietta Refining Co.
William E. Jordan, Wm. E. Jordan, Inc.
Elvin H. Killheffer and Dyer S. Moss, Newport Chemical Works, Inc.
Theo. R. L. Lond, N. Y. Quinine & Chemical Works.
Alex. T. O'Brien, Pharma-Chemical Corp.
A. H. Pierce, Grasselli Chemical Co.
Oscar K. Schwartz, Walter E. Sykes Co.
Edwin C. Scott, Wing & Evans, Inc.
Fred. E. Signer, Butterworth-Judson Corp.
P. S. Tilden, E. I. du Pont de Nemours & Co.
W. H. Van Winkel, W. H. Van Winkel, Inc.

The enthusiasm of those present, with the endorsement of others unable to attend, for organization in a field that offers great opportunity for service to those identified with it, prompted the appointment of an organization committee of which Fred. E. Signer is chairman and William Haynes, editor *Drug and Chemical Markets*, is secretary. This committee will draft a constitution and arrange for a general meeting on the occasion of the chemical exposition to which all sales executives and salesmen in the chemical industry are requested to attend and to send their names to the secretary at 3 Park Place, New York.

Membership in the proposed organization whose activities, it is said, will not embrace price problems or sales policies will be on an individual basis and will include those engaged in the selling and advertising of chemicals.

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BUSINESS revival in certain lines of production directs attention to the conditions precedent to the general resumption of industrial activity. That these lines of production were the first to succumb to the blight of reduced purchasing capacity, felt first in our foreign sales and rapidly extended to domestic markets, leads many to believe that we have reached the low point in the deflationary process and that subsequent progress will reflect more rapid adjustment of the unbalanced state of industry.

Present economic conditions in America are disclosed by a study of the following table:

(Normal Production Equals 100)

	Jan.	Feb.	Mar.	April	May	June
Anthracite coal mined.....	101.3	110.8	93.4	98.2	88.9	94.1
Bituminous coal mined.....	73.6	64.0	57.4	64.0	67.3	65.9
Pig iron production.....	70.0	59.1	44.4	33.2	31.7	30.8
Steel ingot production.....	58.3	48.8	40.0	30.9	31.9	26.5
Tin deliveries.....	30.1	30.7	32.6	30.8	23.7	30.8
Cement production.....	77.8	70.3	88.2	87.7	82.8	83.6
Cotton consumption.....	54.8	66.7	66.1	63.6	67.1	72.5
Wool consumption.....	55.4	67.1	87.8	98.4	105.2	106.6
Sugar meltings.....	53.6	77.9	120.0	95.9	80.3	79.2
Wheat flour milled.....	79.6	80.0	107.9	113.7	104.6	116.1
Wheat slaughtered.....	88.2	92.2	91.9	101.1	96.9	102.0

Normal activity in the chemically-controlled textile industries which are large consumers of a wide range of chemical products augurs well for the chemical industry. The manufacture of Portland cement, a chemical product, holds up fairly well under the stimulus of municipal enterprise to give employment to labor and not from activity in housing construction, a field demoralized by the inordinate demands of a hierarchy of labor that would exploit the people to the extreme of its own disadvantage.

Subnormal production of bituminous coal reflects the general prostration of industry, to say nothing of the influence of a labor charge of \$4.00 per ton as compared with one of \$1.80 in 1913 as result of a wage agreement of \$6.50-\$7 per day expiring not until April, 1922. A wage rate that restricts production 30 per cent, with proportionate unemployment, like the ripples from the pebble cast into the pond, carries its abnormality into the markets of everything obtained from coal.

Despite considerable price reductions long-delayed in the metallurgy of iron and steel, a wage rate entirely

out of line with that prevailing in non-ferrous lines contributes its obstacle to distribution, expressed in a present operating capacity of 25 per cent. In contrast to the coal miner and as an exhibit of the inequality of response to economic law, the metal miner works at a pre-war wage with the metal mining industry operating at 50 per cent. capacity.

The transportation industry, thus shorn of the bulk of its patronage and bearing the incubus of a wage rate glaringly incommensurate with the service rendered and imposed by a politically-pampered class, is made as impotent to display its tremendous purchasing capacity as was Samson his strength by the deceptions of Delilah.

THIS inequality of values as between the various classes of goods and services, which is the root of the present industrial prostration, is but the outward expression of a perverse philosophy that must change if the common weal is to be served.

That it can be changed only under the compulsion of distress is a commentary on the effectiveness of force over suasion—of the refractoriness of passion to the influences of education.

We are beset by groups and classes flushed by the effrontery of "rights" and regardless of service rendered; who put section above society and regard the latter as the subject of tribute and forever keep it in turmoil by the projection of unnatural processes from which all eventually suffer.

The only "right" one has is to serve that for which he exists, viz., society; and when groups and classes seek to reverse this relationship, to the corresponding degree is the revulsion which we are experiencing today.

It is only necessary to refer not to the Dark Ages but to present conditions in Russia to show the malevolence of ignorance and the beneficence of education in human progress.

TO accept a spotted improvement in wholesale prices as an indication that the bottom of the depression has been reached is to ignore other factors essential to recuperation.

Price reductions now are dependent upon wage reductions which must follow in manufacturing and transportation; otherwise living costs will rise under an unwholesome system of curtailing agricultural production to meet the restriction that seeks to maintain wages and prices of factory products at an unfair level above farm products.

Such procedure is fatal to increased productivity which is essential to improved living conditions and only can prolong depression.

A permanent improvement can not be expected so long as artificial restrictions, imposed by politicians and labor demagogues on our fundamental industries which determine largely conditions in all other industries, are set up to displace the play of economic law.

The oscillations of prices, profits, wages, interest and

rent are not synchronous. Each must undergo liquidation, which in totality barely has been entered upon, if the standard of living which means an ever-increasing abundance of cheaper goods is to be maintained.

TO the dependence of modern warfare upon chemistry, to the transfer to America of chemical manufacture heretofore monopolized by Germany and to the widespread recognition of its possibilities in the production of wealth are due the remarkable growth of chemical industry in America.

The last cause which has manifested itself variously but notably in the geographical distribution of chemical enterprise, determined by location of raw materials and proximity to markets, lays a responsibility upon American chemists, which up to the present only those of one state have measured up to.

The intimacy of chemistry's relation to daily life, the absolute necessity of knowledge of its principles and practice in the development and conservation of our natural resources and in the control of the great instrumentalities of public service of water supply, sanitation and public health, have created for the science and art of chemistry a following granted to no other department of knowledge.

The popularization of the science and art of chemistry has infinite material reflections upon the business of chemistry. That much has been done in this direction is evidenced by the indifferent reaction of the people to the malicious political misrepresentation in current dyestuffs legislation in opposition to the requirements of national welfare.

We wish to emphasize the desirability and need of making concrete and vocal the growing popular interest in this fundamental science.

THE favored man owes a duty to his fellows to share his favor for in this way lies progress with its mutuality of growth.

Chemical organization in America, in its cumbersome and highly ineffective expression, ignores the people and emphasizes a federalistic centralization which demands from its followers such measure of devotion as to leave them cold to the responsibilities of citizenship in their own communities.

In the formation of state chemical societies that would serve to focus and express the chemical interests of the respective states, lies a challenge to public-spirited chemists to make such state organization an instrument of education and service unsurpassed by anything of its kind.

In its educational activities such state organization would be for the people of the state what the embracing organization is to chemists. Here is a practicable and needed way for the effective penetration of chemical knowledge into the comprehension of people interested in its development, curious to learn or engaged in the many ways in its practice.

The New Jersey Chemical Society is a precedent for state enterprise among chemists in the way suggested. In three years, because of the performance

of useful functions, it has acquired prestige that ranks it among other organized activities of the state in finance, production, transportation and trade.

Chemists never will exert the influence of which they are capable and which society has a right to expect of its educated men until they participate in the work of leadership in their respective communities.

PRODUCTION of substitutes for more costly things is one of the pre-eminent contributions of the chemist to the progress of material civilization. Without enumerating a long list of such substitutes in universal daily use in life and industry they can be classified as (1) foods and (2) products of utility.

The use of substitutes for non-alimentary products is a part of the progress of the industrial arts and is merely an aspect of the service of industry in the increasing production of cheaper goods.

The same process in food production has met with the hostility and political repression of interests notable as the most inefficient type of human enterprise. Taxation designed to suppress the production of a wholesome food has failed utterly to suppress a demand the satisfaction of which agriculture arrogates to itself in the face of production lagging increasingly behind consumption.

To replace the fat of milk, sold as butter at *prisés* that deny its use to millions, with a vegetable oil is a process far from inimical to human welfare and related more to price and labeling than to the mooted subject of vitamins.

The situation calls not for class legislation destructive of chemical enterprise, but for the activity of the Federal Trade Commission.

WE request respectfully the consideration by the thousands of chemically educated men in America of the current contribution to the subject of an economic organization of chemists. We invite attention to the analogies there set forth and to the recurrence in this country today of a situation of fifty years ago in Great Britain.

We particularly emphasize to broadminded, forward-looking American chemists that thwarted natural development expressing the aspirations of progressive men can result only in distorted growths—in fact, has resulted in perversions of the evolutionary process that would make the professional organization of American chemists a secret society within the confines of a popular organization.

Such movement, method and management not only are repugnant to the independent spirit of the American chemist, but are violative of the principles of American institutions and foreign to any precedent or practice in all other associations of technically educated men.

No more forceful argument could be submitted to American chemists to draw to a head the formation of a professional organization whose distinctive objects would be the material welfare and progress of the practitioners of chemistry and the public recognition of their professional status.

The Growth of the Chemical Industry

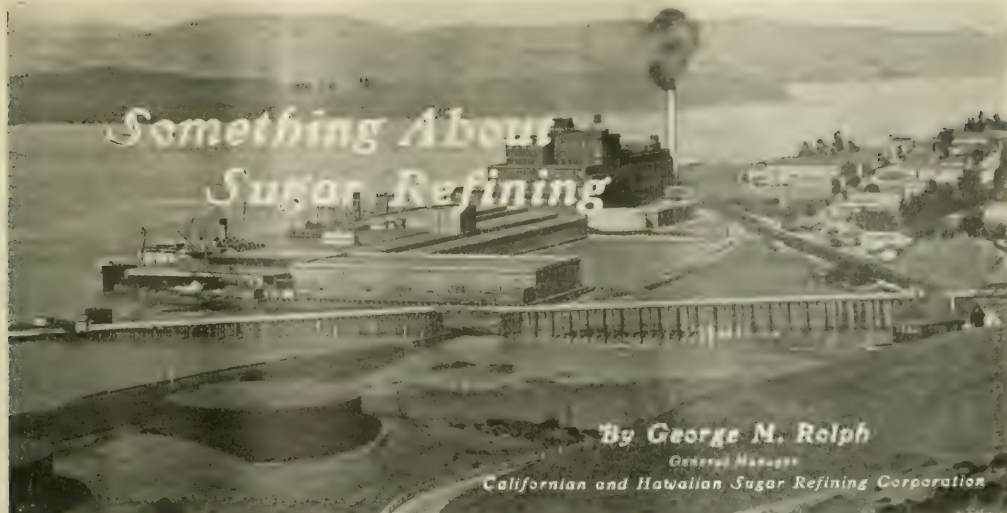
As Shown by the Census Bureau's Preliminary Statement of Selected List of Products for the 5-Year Period, 1914-1919.

	No. of Estab.	Value	No. of Estab.	Value
	1914	1919	1914	1919
Chemical industry.....	589	\$438,692,100	395	\$158,053,060
Coal-tar products industry.....	183	125,482,100	32	15,215,500
Sulphuric, nitric and mixed acids industry.....	29	31,070,500	327	26,926,700
Subsidiary chemical products, other industries.....	583	91,487,600	754	\$200,195,800
TOTAL.....	1,374	\$594,643,000		
Acidst.....	Quantity	Value	Quantity	Value
Acetic and pyroglutamic.....	46,821,000	\$78,117,800	70,617,000	\$30,516,600
Acetic.....	2,816,300	4,556,600	578,600	1,272,300
Acetic anhydride.....	1,433,300	2,300,000	8,584,300	589,000
Boric.....	14,484,100	1,753,600	1,516,300	589,000
Carbonic.....	3,163,700	3,437,400	2,657,800	1,348,800
Chloric.....	147,130	4,041,000	85,440	1,348,800
Hydrochloric.....	5,068,600	5,750,000	5,750,000	5,750,000
Hydrofluoric.....	38,430	4,426,000	4,225	2,094,600
Hydrocyanic.....	19,440	2,976,100	14,685	1,591,600
Nitric.....	44,350,600	6,548,600	21,932,700	1,301,400
Phosphoric.....	14,570,500	1,711,100	12,449,300	680,300
Sulphuric (free SO ₃).....	3,286,700	3,568,400	2,338,280	15,395,100
Sulphuric (basic SO ₃).....	5,054,540	781,500	.....	.....
Oxalic.....	2,103,500	4,545,600	.....	.....
Tartaric.....	5,513,000	3,613,500	.....	.....
Sulphur and Sulphur Compounds.....	90,913,100	.....	.....	.....
Boracohone.....	141,560	3,695,400	90,170	32,594,800
Borax.....	21,435	4,623,300	20,500	2,071,800
Caustic soda.....	37,800	20,400,800	212,540	6,657,500
Salt soda.....	71,830	3,195,200	695,305	10,937,900
Sodium bicarbonate.....	1,033,480	22,990	11,820	1,125,400
Sodium phosphate.....	22,850	2,438,900	15,400	833,500
Silicate.....	286,790	6,052,300	169,050	1,648,900
Sulphate (Glauber salts).....	175,010	2,484,300	99,440	827,600
Sulphates.....	35,180	2,316,300	20,260	516,600
Potash and Potassium compounds.....	.....	9,730,500	.....	.....
Bicarbonate (cream of tartar).....	1,883,550	16,409,500	7,219,900	4,584,600
Prash from original sources.....	1,265,000	2,830,400	.....	.....
Other.....	106,000	7,110,100	12,646,120	51,255,000
Alums.....	327,070	4,515,600	.....	.....
Ammonia and cyanogen compounds.....	.....	16,677,600	158,860	3,468,000
Ammonia.....	27,350	46,340,900	63,310	8,065,000
Ammonium.....	16,680	3,345,400	17,720	3,140,900
Ammonium chloride.....	6,600	1,426,100	5,760	641,100
Ammonium sulphate.....	294,880	22,638,600	4,423	211,300
Other ammonium salts.....	.....	2,476,300	.....	.....
Bleaching compounds.....	.....	10,833,000	.....	.....
Chlorine.....	34,391,800	1,425,900	12,317,000	260,800
Hypochlorite, lime.....	88,570	3,418,500	1,551,000	2,038,700
Hypochlorite, sodium.....	37,860	1,362,800	672,900	5,300,000
Peroxide, oxygen.....	31,515,000	2,257,300	.....	.....
Sodium bisulphite.....	38,217,000	948,700	.....	.....
Other sulphur bleaches.....	.....	129,300	.....	.....
All other.....	.....	592,200	.....	.....
Color products.....	.....	133,340,900	.....	.....
Dyes.....	.....	69,632,500	.....	.....
Color lakes.....	.....	63,402,200	.....	.....
Photographic chemicals.....	.....	7,569,900	.....	.....
Medicinals.....	.....	325,500	.....	.....
Pharmaceuticals.....	.....	6,778,000	.....	.....
Perfume materials.....	.....	1,318,600	.....	.....
Synthetic phenolic resins.....	.....	41,400	.....	.....
Crudes and intermediates.....	.....	3,094,600	.....	.....

¹ Coal-tar acids included with "coal-tar products."
² Not including Ammonium sulphate product of by-product coke and gas plants 88,400 tons, value \$4,800,786.

	Quantity	Value	Quantity	Value
	1914	1919	1914	1919
Compressed and liquefied gases.....				
Carbon dioxide.....				
Nitrous oxide.....				
Oxygen.....				
Other.....				
Phosphorus.....				
Hydroxyl.....				
Rubber substitutes.....				
Viscose, collodion and other.....				
Chemicals produced by the aid of electricity.....				
Not elsewhere included (aluminum, calcium, etc.).....				
Included in other groups (duplication).....				
Aldehydes-formaldehyde.....				
Other.....				
Esters.....				
Acetyl acetate.....				
Ethyl acetate.....				
Ethyl chloride.....				
Other.....				
Ethers.....				
Ethyl sulphuric.....				
Other.....				
Ketones.....				
Acetone.....				
Methyl ethyl.....				
Misc. organic chemicals.....				
Carbon tetrachloride.....				
Chloroform.....				
Glycerine, refined (for sale).....				
Valium.....				
Other.....				
Metal Salts N. E. S. (Salts of):				
Antimony.....				
Arsenic (other than lead arsenate).....				
Barium.....				
Bismuth.....				
Calcium, acetate.....				
Calcium, chloride.....				
Calcium, phosphate.....				
Chromium.....				
Cobalt.....				
Copper sulphate (blue vitriol).....				
Copper, other salts.....				
Iron, sulphate (compas).....				
Lead, arsenate.....				
Lead, acetate.....				
Magnesium, sulphate (Epsom salts).....				
Magnesium, oxide (Caustic).....				
Magnesium, carbonate (precipitated).....				
Magnesium, other salts.....				
Nickel.....				
Silver, nitrate.....				
Silver, other salts.....				
Strontium.....				
Tin, chloride.....				
Zinc, chloride.....				
Zinc, sulphate.....				
Zinc, other salts.....				
Radium.....				
Other chemicals, N. E. S. and uranium.....				
Chemical by-products and residues.....				
Other by-products and contract work.....				

³ Includes acetylene, hydrogen, nitrogen, argon, etc.
⁴ Not including acetylene in containers 121,606 M. cu. ft.; \$2,317,605; which was included in the manufacturing value of acetylene.
⁵ Figures not available.



Plant of Californian and Hawaiian Sugar Refining Corp., Comstock, Cal.

SUCROSE is derived from sugar cane, maple sap, sorghum and the sugar beet. It is a solid, crystallizing in the form of monoclinic prisms, generally with hemihedral faces which are colorless, transparent, have a sweet taste, a specific gravity of 1.6 and a melting point of about 320°. It is soluble in about one-half its weight in cold water and in boiling water in almost all proportions. It is practically insoluble in alcohol, turpentine, ether, chloroform and similar fluids.*

The Sugar Cane

Sugar cane, described in botany as *Saccharum officinarum*, is a giant-stemmed perennial grass that grows from 8-24 feet long. When ripe it produces at the top of its stalk a large feathery plume of flowers of a gray inflorescence called the tassel, which is from 2-4 feet in length. There are many kinds of cane, all of which are regarded as varieties of one species, although some botanists have raised a few to the rank of distinct species. The cultivated type are distinguished by the color of the internodes—yellow, red, purple or striped, and by other general characteristics.

The stem of the cane is solid, with joints at intervals of 3-6 inches. In diameter it ranges from 1-2½ inches, and is unbranched, bearing in its upper parts numerous long narrow grass-like leaves arranged in two rows. The leaves spring from large sheaths around the joints and have a more or less spreading blade from 3-5 feet in length, and 2 inches, or more, in width.

The pith, or open cellular structure, contains the sugary juice. The tops, which contain but little sugar, are not crushed, but are used for seed, as the plant germinates from the eyes or buds which grow on the stems around the joints. Practically no cultivated cane is propagated from its seed. The roots that remain in the ground after the cane is harvested throw up fresh cane or ratoons for many seasons, after which replanting is necessary. Hawaiian growers do not count on ratoons for more than a few crops, whereas in Cuba this process can be repeated for many years.

As a rule, sugar cane consists of about 88 per cent of juice, and 12 per cent of fibre, the juice-content varying from time to time, both as regards quality and quantity. The quantity of juice pressed from the cane determines the efficiency of extraction, while quality is the main factor when the results of the subsequent manufacture is under analysis.

Hawaiian Cane Culture

The planting of the cane in Hawaii usually begins in March and continues until September, sometimes later, and the cane ripens one year from the following December. Growing cane should be watered every seven days, and the amount of water used for this purpose is enormous. For example, a plantation producing 35,000 tons of raw sugar per annum requires twice as much water per day as the City of San Francisco.

In December and January the cane tassels or flowers, which indicates that it has about reached maturity and is ready for cutting. As the ripening process goes on, the contents of the cane juice is changed by the action of the sun's rays and the amount of sucrose as determined by polariscope tests shows when the time of harvesting is at hand. The harvesting then begins and continues until the end of July or August.

Raw Sugar Manufacture in Hawaii

The operations necessary for making raw cane sugar from the sugar cane are as follows:

1. Extraction of juice.
2. Purification of juice.
3. Evaporation of juice to the syrup point.
4. Concentration and crystallization of syrup.
5. Preparation of the crystals or grains for market by separating them from the molasses.

After passing the scales, the cars containing the cane are switched along past the carrier which feeds the cane into the mill. The cane is taken from the cars by a mechanical unloader, which takes them onward and upward to the crusher. The crusher consists of two large rolls with immense interlocking corrugated teeth on the circumference of each. The juice squeezed out by this preliminary crushing runs through a metal trough into a large juice-tank.

* Presented May 19, 1921, before lunch chapter of A. S. M. E., San Francisco, Cal.

Initial Work of the Chemist

The juice as it comes from the mills contains impurities such as dirt from the fields, small pieces of cane-stalks and other foreign matter. It is necessary to remove as many of these substances as possible. This is where the chemist's work begins. The juice is pumped to the top floor of the mill and there a solution of milk-of-lime is added in sufficient proportion to neutralize the acidity. The mixture is then heated and the hot juice run into large settling tanks.

After settling for a time, the clear juice is drawn off. The juice then goes through filters, where practically all the remaining foreign matter is caught and retained in the fibre excelsior in these filter tanks. The clear juice is run to the receiving tanks for the evaporators. The clarified juice from the settling tanks, filters or presses is light brown in color, but is thin as water, and must now be reduced to syrup. All the suspended impurities have been removed, but soluble impurities and the original coloring matter remain.

The object to be attained in a raw-sugar house is the production of a sugar containing 96 per cent of sucrose and little or nothing is to be gained in carrying the process of manufacture beyond this content. Final extraction of all impurities and conversion of the impure raw sugar into pure white granulated sugar is the work of the refinery.

The juice is boiled in a multiple evaporator. The juice in passing through these evaporating bodies is reduced to a syrup containing about 35 per cent water and 65 per cent solid matter. It is pumped out of the last body into a receiving tank for the vacuum pan, where the syrup is boiled, forming crystals. The crystals thus formed are subsequently removed from the solution by means of centrifugal machines. The sugar when ready is drawn off into sacks holding about 125 pounds each. These sacks are sewed by machinery and put into railroad cars to be hauled to the docks at the shipping port where the cars are switched under cranes to be unloaded into sea-going steamers to be transported to the sugar refinery at Crockett, California.

Receipt and Storage of Raw Sugar

The main refinery building of our plant was constructed in the early eighties and was known as the Starr flour mill. It later was converted into a beet-sugar mill and since 1905 has been operated exclusively for the refining of cane sugar. The site is a most admirable one combining both rail and deep water facilities for shipping and receiving sugar.

The raw sugar is received in cargoes ranging from 5,000-12,000 tons and comes from the ports of Honolulu, Hilo, Kahului, Port Allen and others of lesser importance.

The Hawaiian raw sugar plantations begin producing the season's crop of raw sugar in December and finish the harvest in July or August. The refinery usually begins operations early in January and completes the year's work about December 1st. While the plantations produce raw material over a period of eight months, the refinery operates eleven months which fact makes necessary large warehousing facilities during the fall months sufficient to store three months' supply of raws and at least 30 days production of refined or a total of about 150,000 tons.

The incoming cargoes are discharged into the warehouse or sent direct to the melt. Many schemes have been devised for handling the sugar from the ship to the dock by conveyors but as yet nothing successfully has replaced the sling and derrick. After the sugar is land-

ed on the dock it is sorted as to brand and then weighed in the presence of a representative of the refinery and a representative of the producers. Both men record the weights which are accepted as the basis of the sale and purchase. As the truck passes the scales a tryer is driven into a sack and a sample taken. From the truck the sacks are dropped on conveyors and sent either to storage or to the refinery.

In reconstructing the refinery a raw sugar storage bin was constructed with a capacity of 1500 tons. This large storage bin makes it possible to send fully 2/3 of the sugar to be melted in the 24 hours direct from the ship without being stored in the warehouse, eliminating unnecessary handling. All moving of sugar to and from storage is done by conveyors, reducing labor to the minimum.

Our new dock is double-deck, sugar being discharged simultaneously on the upper and lower levels. It costs the steamship company about 30 cents a ton to discharge its cargoes at Crockett which is much lower than can be done at any other dock.

Marine Borers and Capital Investment

The convenience of having both rail and water together in an industry, while always quite expensive, sometimes has unexpected hazards. The old factory and warehouse were constructed out over the water supported upon green piling. The first piles for the support of the old Starr flour mill were driven in 1881. It was 36 years later that we began the reconstruction of the old plant in January, 1917. Precedent is sometimes a good thing to follow and at times very dangerous. It was so with us. We made a very careful examination of the foundations of the old structures and found the piling in good condition, green sticks well preserved, and there appeared no good reason for not continuing to use green piling since the old ones were sound at the end of 36 years. We had not progressed far in the reconstruction program when in breaking-off piles that interfered with the new work we discovered a few sickly teredos.

On this meager information the type of construction to be used was changed immediately which added approximately \$2,000,000.00 to the cost of the improvements. While a small matter at the time subsequent events have proven to us that it was the most far-reaching decision that had to be made and averted a near catastrophe. It has been much easier to explain why the cost ran far above the preliminary estimates than it would be now to explain the failure of the foundations while during the past year structures have failed all about us. Yet some of our neighbors stated as late as the spring of 1919 that their structures were not attacked by marine borers. Today green piling is destroyed within a year.

Marine Borers and Scientific Research

Many engineers yet do not seem to grasp the real significance of this sudden attack by marine borers in the upper waters of San Francisco Bay. Following a talk given before the American Society of Civil Engineers last June a committee of engineers organized what is now known as the San Francisco Bay Marine Piling Committee affiliated with the American Wood Preservers' Association to make a survey of the situation. The committee published its first preliminary report in January of this year. The great interest in the work made it possible for the committee to raise \$30,000 to continue the work over the next three years, the money being subscribed by those who are more or less interested in waterfront construction.

In undertaking the work the cooperation of the scientists of the University of California was enlisted and particularly that of Dr. Chas. A. Kofoid, head of the Department of Zoology, who is probably the greatest authority in this country on the subject of marine borers. All available data on the subject have been brought together by the committee and it found that very little research work on the subject has ever been undertaken.

The committee has established observation posts throughout the entire bay region receiving samples and installing testing pieces at each place. In the investigations it found that the borers which caused the tremendous damage in the upper-bay regions of San Francisco Bay are newcomers to our shore, never having been reported at any former time. They have been proven to be the same species, viz. the *teredo navalis*, which has been causing great damage to the dikes of Holland for past centuries, and readily adapt themselves to living in both brackish and salt water. Heretofore it has been generally supposed that marine borers would not be active in water containing less than 1 per cent. of salt, but we find them living and thriving and breeding at Crockett where the water is practically fresh so that the former theories have had to be discarded and we have been forced to the conclusion that comparatively little is known authoritatively on the subject. It does seem, however, that from this time on the Upper Bay water will be infested by these borers.

Present "Creosote" Wood Preservative

Some of the creosote piling driven in the bay region in recent years are now subjected to attack by borers. This indicates that the creosote oil was in some way defective. A close study showed that the manufacturers were removing the "Dye Basis" portion of the oil, i.e., naphthalene, anthracene, pyridine, acridine, quinoline and aniline, all of which constitute the heavier oils leaving the lighter oils which more readily leach out. In reality the creosote oil now on the market is a by-product and not a whole oil. The committee is now revising specifications so as to insure the user that he is getting the best grade possible, not however without vociferous objections on the part of some of the producers.

Marine Borers and the National Research Council

Great interest throughout the country has attached to the work being accomplished by the committee. The National Research Council is cooperating, looking into conditions in Eastern harbors, notably New York, as the conditions there are analogous to those in the vicinity of Crockett. With the foreign species active in American waters it would seem possible that all of our coastal waters may ultimately be infested, causing the loss of many millions of dollars.

Sugar Refining

Sugar refining has no secrets, the methods used being practically identical in all plants with slight modifications here and there depending on the management.

Sugar is transferred either from the steamer at the dock or from storage direct to the refinery by conveyors. As the sacks of sugar come into the factory on the fourth floor of the melt house they are opened and the contents dumped through a grating into a large bin with a capacity of 1500 tons. The lumps that are formed while the sugar is in transit from the Islands are run through a crusher. The empty raw-sugar bags are sent by overhead conveyor from the cut-in station to the bag laundry. With a melt of 2,000 tons a day there remains in the empty bags approximately 10,000 pounds of raw

sugar which is removed in the laundry and entirely recovered in the form of sweet-water. The raw-sugar bags after being washed are dried, repaired, printed and reused for packing sugar.

Washing Raw Sugar

The raw sugar is dumped through openings in the bottom of the bin into scraper-conveyors; thence it is carried into elevators which take it to the top of the melt-house and discharge it into the minglers where it is mixed with "washed syrup." The addition of this syrup reduces the raw sugar to a mushy mass called "magma," which is then run into centrifugal machines. The syrup that has been added is first spun off carrying with it a small percentage of impurities.

At this point we have made one of our greatest improvements in the art of sugar-refining. Our new Watson-Laidlaw centrifugals are a decided improvement over the old belt-driven type. While not new in principle they have been so modified at Crockett as to be adaptable to this purpose. This centrifugal is self-discharging and requires no mechanical device or manual labor to discharge the washed sugar. This is the great advantage over the old closed-bottom type which requires approximately 20 per cent of the total time of the cycle for discharging. While this saving of time does not appear large it means that this new type of centrifugal will handle 25 per cent more charges per 23 hour day. These new machines are motor-driven instead of belt-driven, thus insuring a more uniform acceleration and economy in power. This centrifugal is approximately double the capacity of the old type, having a diameter of 48 in. and a height of the vertical section of 24 in. The bottom of the centrifugal is open, the opening being 33½ in. in diameter. The lower 15½ in. of the basket tapers at an angle of 60°. The calculated capacity is 11.9 cubic feet with a wall thickness of magma of six inches.

Approximately five seconds after the centrifugal is started the basket reaches a speed of 250 R. P. M. which is considered the right time to charge. The magma is allowed to flow into the centrifugal and is distributed by a distributing disc. It requires 20 seconds to charge and at the end of this time the basket is revolving at a speed of 650 R. P. M. While the basket has an apparent capacity of 11.9 cubic feet, due to the rapid acceleration while charging, a large percentage of the syrup is thrown out and is replaced by new magma which gives the centrifugal an actual capacity of slightly more than 15 cubic feet.

After the full charge is in, the centrifugal is allowed to spin off the syrup which requires about 45 seconds. During this time the basket comes to full speed of 870 R. P. M. Washing-water is applied for a period of 75-90 seconds to wash-off the impurities from the outside of the grain. The amount of water used in washing the sugar is measured, approximately 34 pounds per charge, and applied from two nozzles so placed and arranged that a fine spray of cold water reaches every part of the sugar wall. The water is supplied by a centrifugal pump giving a constant pressure of 40 pounds. After the water is shut off the spinning continues for 30 seconds to dry the sugar after which the power is shut off and the brake applied. It then requires two minutes to bring the machine to a stop. A moment or two before the centrifugal comes to a stop the washed sugar, which still contains two per cent of water drops from the bottom of the basket into the washed-sugar bin. The entire lot discharges automatically in two seconds due to gravity and the slanting bottom.

This magma weighs 80 pounds per cubic foot so that each charge consists of approximately 1220 pounds. From this we recover about 710 pounds of washed sugar or a yield of 58 per cent. Raw sugar entering the "cut-in" station has an average purity of 96½ per cent, while the washed sugar leaving the centrifugals is approximately 99 per cent pure. The loss of raw sugar in weight through the washing process varies from 8-12 per cent, according to the purity of the resulting raw sugar. Each of these self-discharging centrifugals has a daily capacity of 100 tons of raw sugar, compared with the 50-ton capacity old-type machine. Thus our present installation of 22 centrifugals is equal to 44 of the old type. A man operates as many of the new type as the old thus the labor cost is cut in half in addition to conserving greatly floor space.

Melting the Washed Raw Sugar

The sugar passes from the washed-sugar bin to the premelters which are large troughs, provided with mechanical agitators in the bottom, to which is added hot water and sweet-water of approximately the same purity as the raw sugar itself. About 87 per cent, of the water used in the premelters is sweet-water, one of the by-products of the filtering process. The melting of the raw sugar is very important as the quantity of sugar and water entering the premelters must be kept at such a proportion that the resulting mixture will be of constant density and nearly as possible at constant temperature. To regulate the temperature open-steam injectors are used in these premelters. The final adjustment of the temperature and density of the raw liquor is made at the main melting tanks where the final liquor is screened to take out some of the impurities, such as burlap, etc.; then it is pumped to the blow-ups in the char-house. One gallon of this raw liquor at a density of 62° Brix weighs 10.85 pounds and contains 6.73 pounds of solid.

Blow-Up Tanks

The blow-up tanks are cast iron with a capacity of 3900 gallons each, are ten feet in diameter by six feet high, cone bottom. Kieselguhr is then added which forms a cake. Lime also is added to aid precipitation. A mixture of lime, kieselguhr and liquor is then run into the Sweetland presses where all impurities in suspension are removed. Approximately 23 pounds of kieselguhr are required per ton of raw sugar melted.

The regularity with which the blow-up station is operated will in a large measure determine the operations of the entire refinery. At this point the superintendent can at a glance determine just what has been done up to any time of the 24 hours and keep very close touch with the progress of the day's work.

Filtration

From the blow-ups the liquor passes to the Sweetland filters. This is another station that has been revolutionized in recent years. Filtration to remove insoluble impurities formerly was done in bag filters. These were large tanks provided with connections at the top for the suspension of bags, the liquor running into the bags, filtering through and being drawn-off below. They never were very satisfactory; the filtrate rarely was clear and free from the superficial impurities and was what is called by the sugar-refiner as "cloudy." The Sweetland filters have in a large measure revolutionized this portion of the process. They have eliminated a large part of the labor and done away with an exceedingly disagreeable task.

Operation of the Sweetland Filter

The filter is prepared to receive the filtrate by closing the bottom discharge and opening the vent pipe to release the air which is replaced by the liquor. Then the body of the filter is filled with what is known as "smear liquor." This is a graded liquor which contains a higher percentage of filtercel than the ordinary product. The smearing of the filter is done under gravity pressure requiring about two minutes. As soon as the filter is full the vent is closed and the filtrate running from outlet is diverted into a cloudy liquor tank until it runs clear. Then it is diverted into the clear-liquor receiving tanks.

A Sweetland press holds approximately 630 gallons and from 20-40 gallons are returned for refiltering at the beginning of each cycle before it is cleared up. After the filtrate is clear the filter is put under pressure beginning with 10 pounds pressure per square inch and increased gradually until 50 pounds is reached. At this point the filter produces approximately fifteen gallons per square foot of filter surface per hour. Gradually reducing the rate of filtering until at the end of 60 minutes the rate of filtering is approximately one-fourth gallon per square foot of filter surface, making an average of approximately two and three-fourths gallons per square foot for the period of the cycle. The Sweetland press has an effective filtering area of 1044 sq. ft., contains 72 leaves each with an area of 14.5 sq. ft., and will handle raw liquor equivalent to 100 tons of raw sugar per 24-hour period in from 16-18 cycles.

After the pores of the filter have become clogged and the pressure is taken off, the liquor remaining in the filter is discharged and sent back to the blow-ups. The leaves of the filter are cleaned of impurities and the cake of filtercel. This is done by means of a spraying device which is located in the upper part of the shell consisting of a pipe in which are inserted small nozzles with ⅛ or ⅜-in. openings. These are placed on 2-in. centers the same as the leaves. By means of a timing device the spray moves slowly between the leaves and releases small streams of water in a rotary movement at 45 pounds pressure.

The impurities thus removed are sent to the dirty sluice-water tanks to be in turn filtered through mud-presses and the sweet-water thus recovered is used in sluicing the Sweetlands. In sluicing the Sweetlands it requires 48,000 gallons of water per 100 tons of raw sugar, the average time of sluicing being about 10 minutes and approximately 1900 gallons of water is used per filter. The Sweetland press is then ready to be used again. The filter cloth used in these presses is a light cotton twill having a life of from 60-75 days although at our plant they are removed regularly at the end of 45 days of service.

Char-Filters

From the filter presses the liquor goes to receiving tanks for the storage of the different syrups and liquors before entering the char-filters. Each grade of liquor and syrup is separated here according to the purity of the product, and the final adjustment as to temperature, alkalinity, density, etc., is made. From the receiving tanks the liquors run by gravity to the char-filters below where practically all the coloring matter is removed.

The char-tanks are cylindrical cast iron vessels 26 ft. high by 10 ft. in diameter with a capacity of 52 tons of animal charcoal. The liquor enters the filter through the supply line at the top and is drawn off from the bottom. The average purity of the first liquor leaving

the char-filter is from 99.2-99.5 per cent. This high-grade material is used for the manufacture of specialties such as cube, confectioners' sugar, etc. During this process the liquor is filtered under pressure of from fifteen to eighteen pounds. The quantity flowing through the char-filter is regulated, the average being 1250-1350 gallons per hour per filter. This keeps the liquor in contact with the charcoal for approximately 6½ hours. The average time the filter is operating on raw liquor is about 16 hours, handling in this period an average of 20,000 gallons.

The raw liquor is then followed by several grades of liquor entering the filter according to purities and drawn off separately and either pumped to pans to be boiled into granulated sugar or returned to be refiltered. At the end of the filtering period, i.e., when the bone-char has become clogged up, the pressure is shut off and the liquor allowed to settle below the surface of the char, then hot water enters the filter gradually replacing the liquor, forcing the latter out. When the density of this liquor is reduced to about 30° Brix it is changed into what is known as sweetwater. The sweetwater then is run to the evaporator storage-tanks to be concentrated and again reprocessed. The "sweetening-off" of the char is completed when the sweetwater is reduced to a density of approximately .21 per cent of sucrose. After that the char is washed thoroughly, the wash-water going to waste. On a 2,000-ton capacity it requires approximately 900,000 gallons of water per day for the washing of the char-filters alone.

Revivifying Bone Char

Revivification of the bone-char is effected in char-kilns that are heated to from 750-850° F. The reburning of the bone-char decomposes some carbonates to oxides and carbonizes the organic matter which the washing failed to remove, the carbon remaining in the pores of the char to be removed at a later burning. With each burning .15 per cent of the carbon is removed. It has no decolorizing power as it merely clogs the pores of the char and decreases its filtering value. By this process the char is reused about twice a week for an average life of five years. Bone-char is burned animal bones ground and graded as to fineness. Chemically it contains 80 per cent calcium phosphate, 8 per cent carbon, and varying percentages of iron, magnesium, calcium and silica.

Crystallization

All liquor passing from the char-filter flows through the liquor gallery which is a series of troughs. The operator can view every product passing through the plant and diverts it according to its color and purity to its proper station. From the liquor gallery the liquor is pumped to storage tanks near the vacuum pans and drawn from these tanks into the pans to be boiled under vacuum at a temperature of about 170°F. As the water is expelled the sugar crystallizes and is dropped into mixers below to be "spun-off" in centrifugal machines, in this case the old type, much in the same way that the raw sugar was washed at the beginning. White granulated sugar leaving these machines contains approximately 2 per cent. moisture and passes into conveyors and elevators to be taken to the granulators and dryers.

Drying and Grading

Granulating and drying are effected in large revolving cylindrical drums in which the sugar is dried by hot dry air passing through it. When the sugar comes from

the dryers it is of various sized grains and is passed over a magnetic separator to remove any iron substances. It is then fed by the dry sugar elevator into separator screens to be graded into various sizes. Here the sugar is separated according to the sizes of grains forming the "berry" or "fine standard" or "coarse standard" and other grades of sugar.

Spouts are provided whereby the grains of sugar are fed into a storage bin for the packers. The largest grained sugar thus obtained is used for canning purposes and is known as "Canners' Granulated." Next comes two sizes of ordinary grained sugar the larger of which is shipped East while the smaller is sold for consumption in the Pacific States. Bar sugar and the powdered are finer than the "berry." They are made by specially grinding ordinary large grained sugar in mills constructed for the purpose. Bar sugar has an exceedingly small grain, and powdered no grain whatever. Confectioners' sugar is specially boiled and has a large grain of unusual transparency.

Cube sugar is made from granulated to which syrup is added to give it coherence. Cubes are made by forcing sugar through holes in a cylinder and while still in a soft state they are placed on trays and dried by a current of heated air being passed over them in an enclosed compartment. From the storage-sugar bin the sugar is weighed on automatic scales into 100-lb. bags, which are sewed on the sewing conveyor. From this point the bags are taken on the same belt traveling in the opposite direction that brings the raw sugar from the warehouse to the factory.

Calandria Pans

The third radical change in sugar manufacture is in the development of the calandria pans. The calandria pans have a heating surface approximately 56 per cent. greater than the old-type coil pans and are used with exhaust steam at a pressure of about 15 pounds. This change was brought about by the development of our power plant wherein we generate our steam at 150 pounds pressure, run it through turbines and discharge the steam with a back pressure of 10 to 15 pounds, thus obtaining our electric power as a by-product at a comparatively slight cost per kilowatt hour.

Steam Production

The boiler-house is a very important part of a sugar refinery. Normally over one million gallons of water must be heated daily for refinery use and approximately 640,000 gallons evaporated from sugar solutions, or at the rate of 3300 pounds per minute. At the same time we use some 3,000 K. W. H. of power which we formerly purchased. This then presented the possibility of obtaining our power as a by-product of the steam which had to be generated for use in the refinery. The solution of the problem has resulted in the annual saving of thousands of dollars. Last year the fuel used per ton of sugar melted was 13 per cent less than the average for the previous five years notwithstanding our power was a by-product.

When all the exhaust steam is used the power generated costs about one-tenth of a cent per K. W. H.; as we are now operating; at times being unable to use all exhaust steam, it costs ¼c per K. W. H. average. Two new 14-ft. Calandria pans are being installed at present which we hope will permit of a final solution of the steam balance, making use of all exhaust. When operating at 2,000 ton capacity, 1,000,000 gallons of water is evaporated in the boiler plant, approximately one-half of which is return drips. The average CO₂ is 13½ and the boiler efficiency 79 per cent.

Emergency Labor-Saving Device in a Chemical Plant

TO fill a large order for sulphuric acid a shipload of sulphur from Louisiana via the Panama Canal consigned to the San Pablo Bay, California, plant of the Hercules Powder Co., arrived only to find the water at the company's wharves too shallow to accommodate an ocean-going vessel.

Rail transport being more economical than lighterage, the expeditious and cheap handling of an 8000-ton cargo of sulphur received at the plant in car-load lots was a problem that Ralph Robison, the engineering genius of the local organization, solved to the pride and satisfaction of all concerned.

As shown in the uppermost illustration, a hinged frame supporting a bucket conveyor that permitted elevation to allow for the passage of the plant rolling-stock, and depression into the gondola when in use on the job, was the keynote of the song of efficiency that Mr. Robison's crew sang in the unloading of 142 cars of 8,000 long tons of Louisiana sulphur at

to turn them upright and tow them across in a convoy was an expedient resorted to successfully and creditably to the engineering department of the San Pablo plant of the Hercules Powder Co.

No branch of production surpasses the chemical and

The Unloading Device in Process of Construction.



The Plant Sulphur Pile. The Fresno scraper shown at the left in line with the window.

the rate of about 4 cars per 8-hour shift, and without demurrage.

In the operation of the system the elevator was lowered into the mass of sulphur in the car, which gave way to the onslaught of the moving toothed buckets which were advanced to the opposite side of the car when the bottom was reached. The car was moved forward as necessary to provide material until the contents were removed, that portion not taken up by the buckets being shovelled in by hand, so that each car was emptied thoroughly before taken away.

The movable bucket conveyor delivered the material to an elevating conveyor from which it was sent to the sulphur pile where it was levelled by a Fresno scraper operated by a donkey engine.

The engineering department of this plant also is responsible for notable resourcefulness in the transfer of 18 tonol storage tanks 20 feet in diameter and 18 feet high which were sold in the inventory reduction following the Armistice. The terms of sale required their transport to the other side of San Pablo Bay, which was beyond the capacity of the local ferry-boat.

To roll these tanks carefully to the water's edge,



The Unloading Device in Operation.

allied industries in the measure of resourcefulness required of factory administrators. The constant call for operating "kinks," resorts to temporary devices in case of break-downs and repairs, making the best use of often meagre implements at hand, develop an ingenuity peculiar to an art that requires a working knowledge almost of all arts.

The handling of solids, liquids and gases, often corrosive and poisonous and at various extremes of temperature, under the most efficient conditions demands of the executive operator a skilled resourcefulness that is born only of experience. The production chemist as a general utility man has no counterpart in industry.

Handling of Liquids in Coal-Tar Chemical Manufacture

By S. P. Miller

Chemical Engineer, The Barrett Company

THE manufacturer of coal-tar products is called upon to deal with a large variety of materials which, while quite similar, nevertheless usually must be kept entirely separate.

It is necessary to employ in addition to the coal-tar compounds the ordinary inorganic materials, such as sulphuric acid of various concentrations, hydrochloric acid, nitric acid, solutions of nitre cake, sodium nitrate, salt, caustic soda, caustic potash, milk of lime, and sodium carbonate, each of which presents its special problem.

A great number of tanks and a labyrinth of pipe lines are required. Unless continual care is exercised, new lines and equipment creep in where those already in place might have served. An exact knowledge of the inter-relation of products is required to handle the situation economically. The problem appears less simple if it be realized that some 200 crudes, intermediates, and finished products are involved.*

Flexibility of Equipment

The constantly fluctuating business conditions of today require a large amount of apparatus, such as agitators, washers, filters, fusion kettles, nitrators, sulphonators, stills, etc., to be maintained in readiness to produce at odd intervals products which have previously been manufactured steadily. The economic handling of materials becomes a matter of prime importance at this time when the exceedingly small amount of purchasing incites keenest competition on the part of manufacturers.

Receipt of Raw Materials

The crude oils usually arrive in tank cars. Notable exceptions are anthracene and naphthalene, which are shipped in burlap bags; large amounts of the latter, however, also are received in tank cars. A few materials arrive in steel drums; they are emptied at once if possible, as all such packages are regarded as an enormous hazard in case of fire. Coke-oven light oil drip oil, carbolic oil, and crude tar acids constitute, in addition to naphthalene, the great bulk of the crudes.

Immediately after arrival the cars containing them are sampled and placed on a track devoted to unloading and loading. The contents of eight to twelve cars per day can be handled through a central pumping station which delivers the material into storage tanks or directly into stills. Empty cars are either pulled out at once or are moved forward to a cleaning and loading station for refilling with finished products.

Steam-driven duplex pumps are employed; they require less attention than either rotary or centrifugal types, may be worked over a wide range of pumping rates, and can be used safely all over the works; whereas motor-driven equipment can only be used in the absence of inflammable vapors. Crude naphthalene of m.p. 66°-76° C. is pumped with no difficulty into tanks in some cases nearly $\frac{1}{4}$ mile away; the system is thoroughly heated before pumping and the material maintained at 15°-20° above its melting point and moved rapidly.

The only material not handled as indicated is sulphuric acid of 66° B. This is blown by means of air

directly to storage; this system will in the future be replaced by centrifugal pumps.

Storage Equipment

For storage our practice favors the use of vertical, cylindrical tanks, rather than of the horizontal type. With vertical tanks ground space is economized and also the separation of water may be accomplished more readily than in the horizontal type. Vertical tanks may be equipped with try cocks on the side and the draw-off line fixed at a point about eight inches from the bottom of the tank; small quantities of water then collect and are drawn off periodically. This feature is of great importance if the oils are to be distilled, since it minimizes trouble due to priming and effects a great economy of fuel and of distillation capacity.

The importance of removal of water is evident when it is remembered that water requires about 7 times as much heat to evaporate as oil, and that water produces 4-8 times as much vapor per unit volume as the ordinary coal-tar products. Thus the presence of a large percentage of water will give rise to great trouble due to building up of pressure if any considerable rate of distillation is attempted, and condenser troubles also will follow.

We have not yet employed centrifugals for removing water, as their capacities are low, their first cost is high, and the specific gravities of the oils are, in general, sufficiently far from unity to give good separation normally. Thus representative oils, as charged to stills, contain water as follows:—Carbolic oil 5.5 per cent., drip oil 1 per cent., coke oven light oil 1 per cent. A small amount of water is added to the oils in handling, as all lines are blown with steam prior to use; this amount is minimized, however, by blowing into a "slop tank" until the line is warm; the oil then sent through picks up only a very small amount of condensed water.

Each of the tanks of 2,000 gallons or more capacity is equipped with a man-hole on the side near the bottom to provide easy access for cleaning. One or more man-holes in the roof provide means for sampling, inspection, introduction of temporary coils, etc. Tanks of 30,000 gallons capacity and above are usually equipped with inside steel ladders. All are either fitted with individual outside ladders or arranged in groups served by a common platform. Portable ladders are avoided when possible.

Storage vessels containing the more volatile oils, such as benzol, toluol, etc., if located inside buildings, are vented to the outside. Those containing naphthalene are vented by means of a small hole drilled in the tank roof. Relief lines on naphthalene tanks are not safe as they may become clogged with sublimed product; the presence of water in the tank may then cause a pressure sufficient to give trouble. We have seen several hundred gallons of molten naphthalene blown from a tank the vent of which had become clogged and had caused accumulated pressure. The draw-off lines from tanks are supplied with control valves, one within the tank; in case of accident to the outside valve the inside one may be closed.

Certain oils, such as carbolic oil and naphthalene, require to be stored in heated tanks; such tanks should be insulated, since in nearly all cases the cost of insula-

*Presented at meeting of American Society of Chemical Industry, New York, April 22, 1921.

tion is more than offset by the saving over a year. Storage should not be heated until required.

Piping

For pipe lines wrought iron pipe and cast iron fittings are generally used. Those carrying the sodium salts of tar acids and solutions of sodium carbonate and caustic soda should be of steel. Lead lines are required for handling pyridine sulphate, dilute sulphuric acid, and the various acid sludges resulting from washing of oils with sulphuric acid. Piping practice varies so slightly from plant to plant that it requires no further consideration.

Still Construction

The stills are of two types, viz., simple or fractionation. They are either fire or steam-heated, and only in rare cases is live steam blown into the still to assist distillation. They are operated either under 1—2 lb. pressure or under vacuum. The fire-heated stills are either of the direct-fired or of the return-arch type. The Dutch oven setting is not used. In some cases anthracite coal is employed, but most of the fuel consists of tar residues from oils distilled.

Practice varies widely as to the use of return-arches under fire-heated stills. At present direct fires are being used in most cases because a large amount of expensive fire-brick is eliminated, changes in the intensity of the fire are felt at once in the rate of distillation, more sensitive control is possible, and distillation stops immediately if the fire is checked. Residues may be removed immediately the distillation is complete and the still may be at once recharged without danger from priming. This is accounted for by the fact that the setting cools rapidly in the absence of the arch, which always acts as a reservoir for an enormous amount of heat. The open-type setting is more economical of fuel. Thus a much higher rate of distillation is safely possible than with the arch-type still. No trouble due to burned out still bottoms should be experienced; this depends almost entirely upon design.

Fire-heated stills operated under reduced pressures should be equipped with a positive-acting vacuum breaker. This is of prime importance when distilling high-boiling tar acids, as the bottom sheets frequently become red hot during the latter part of the distillation. A common type of breaker consists of a vertical rod, one end of which rests on the still bottom, and the upper end touches a relief valve; if the sheets start to pull in the rod opens the relief valve and prevents further damage by breaking the vacuum.

The greatest economy in the operation of steam-heated stills lies in the saving of steam. Stills should be thoroughly insulated and the heating units should be of sufficient capacity to maintain a maximum rate of distillation, which should depend only on the condensing capacity in the case of simple stills and upon best fractionation in the case of the column stills.

If alterations to existing distillation units are made, or if new units are designed, the greatest care should be given to the determination of proper pipe-line sizes. Abnormally high vapor velocities are not desirable, especially in the case of fractionating stills. Rectifying stills operated under vacuum should receive very careful attention along this line if close-cut fractions are to be made. Care must be exercised to ensure a free flow through the fractionating column of the liquor returned by the dephlegmator. The best results are not possible if flooding within the columns occurs.

Agitators

The agitators used in treating the oils with caustic soda or sulphuric acid are of five types:—(1) Vertical type in which mixing is accomplished by means of a

shaft carrying two sets of propellers. (2) Vertical type in which agitation is secured by means of a slow-moving scraper. This apparatus is particularly useful in operations in which the material tends to stick to the sides or bottom. (3) Horizontal type, in which slow-moving paddles accomplish the result by a tumbling action. This is an excellent machine for use with suspensions of solids. (4) Vertical type, with agitation by means of air introduced at the bottom. This type is of value for use with materials which tend to emulsify if beaten violently, as in the others mentioned. (5) Vertical or horizontal, with the means of agitation outside the vessel.

A centrifugal pump is employed to circulate the liquids out of the bottom and into the top of the agitator. The pump should be of ample size. We are using a vessel of 3,200 gallons capacity in conjunction with a centrifugal pump of 3,500 gallons per minute capacity. A slow-speed, low-head pump is satisfactory. Where extremely efficient agitation is required, this equipment is difficult to equal.

Where large volumes of material are handled through agitators, the question as to the most economical size of equipment arises. Apparatus of large volume, *i. e.*, 7,500-12,000 gallons, in general, has the great disadvantage of not allowing the highly efficient contact between reagents required for greatest economy of time and materials. The use of the centrifugal pump mentioned above appears to offer most opportunity for mixing efficiently large volumes of liquids. This is of first importance in the washing of benzols and solvent naphthas with sulphuric acid, the extraction of tar acids from oils with caustic soda, and similar operations.

We have practically discarded the idea of building large agitators of the batch type. These will gradually be replaced by apparatus for continuous operation, since much smaller units are required for a given output; violent agitation is more easily accomplished in small than in large agitators; a comparatively small volume of product is present and if cooling or heating is necessary, temperature control is far easier than in large equipment; the greater ultimate capacity of the continuous equipment allows a reduction in labor; ease of temperature control tends towards an improved quality of product, as almost all operations require regulated temperatures; repair costs on continuous equipment are lower, as the apparatus is much smaller and more easily handled. In many cases complete spare machines may be kept in stock for replacement in emergency.

It is, of course, true that the amount of material to be handled determines absolutely whether continuous operation is desirable. Rather small productions are satisfactorily dealt with in batch equipment. If, however, several thousand gallons of material are handled daily, the continuous apparatus deserves serious attention.

An example of a continuous process which avoids the use of batch agitators is the Dennis-Bull process (U.S.P. 1,247,999) for continuous sulphonation of benzol. This was operated on a works scale at our plant during the war.

Lead-lined apparatus which must be heated deserves attention. The best practice seems to be to install coils on vertical supports; these are set at least 6 inches from the sheet lead, which in the absence of local overheating will not sag and split. Many costly and irritating repairs are thus avoided.

Centrifugals and Filter Presses

The removal of naphthalene and other solids from refrigerated oils is accomplished in open centrifugals. With a 52-inch machine, the oil may be run through at a rate of roughly 1,000 gallons per hour. A good cake

forms and the removal of solids is complete. The operation is practically continuous. Only oils having very low vapor pressures are handled in this equipment.

Filter-presses of the plate and frame or clam shell types are used for filtration of oils of relatively high vapor pressure. Although not continuous, they have an advantage over the rotary filter in that losses of volatile oils are minimized. Centrifugal pumps are used for charging practically all the filters; in addition to giving excellent service, they have the advantage of a limited pressure capacity. No danger of excessive pressures in presses is possible if proper pumps are chosen initially.

Centrifugal are employed on all those solid products which, for purification, require the elimination of relatively small quantities of oil. Hydraulic pressing does not improve the quality of the materials. The centrifugal has much in its favor, not only from the mechanical standpoint, but also from that of ease of operation. Phenol and naphthalene are purified in centrifugal machines.

Shipment

Liquid products leave the works in tank cars, steel drums, tight barrels, and in various types of tin cans. Naphthalene, phenanthrene, α -naphthylamine, and p -coumarone resin are all shipped in the solid condition. We endeavor, however, to handle these materials as liquids up to the last operation. Common practice in the case of some of these is to allow them to solidify in shallow pans, from which they are subsequently removed, crushed, and packed in barrels. Others are run molten into light-weight metal destructible drums and are allowed to solidify prior to shipment.

Some of these products are now finished in machines similar to those used for flaking caustic soda, sodium sulphite, nitre-cake, shellac, etc. Many advantages are gained; less labor is required; less floor space is occupied by equipment; smaller quantities of inflamma-

ble materials are held in storage at any time, as, being continuous, the flaking machine handles the refined product as fast as it is manufactured. Expensive machines such as there are probably not warranted unless production is large.

Fire and Health Hazards

Fire and health hazards must be given continual attention in a works handling materials which are at once inflammable and injurious to health of workmen. Benzol is the worst offender from all standpoints; it has a flash-point well below 0° C. and forms with air explosive mixtures, as also do toluol, xylol, and solvent naphtha. The entire system of tanks, lines, agitators, and stills should be tightly closed and no open connections of any kind tolerated.

All storage tanks should be vented to the outside atmosphere and preferably into a large line the exit end of which is thoroughly protected from fire and is at a considerable distance from the plant. Buildings should be maintained absolutely free from fumes. Puddles of oil on floors are dangerous. All apparatus should be thoroughly grounded by means of copper wires securely fastened to the apparatus and to a ground wire. Serious fires have resulted from static discharges. Precautions taken to avoid them as of the utmost importance.

Naphthalene is not regarded as poisonous. It does, however, comprise a real fire hazard. It is usually purified by distillation in fire-heated stills. Its tendency to sublime causes blocked lines, safety valves, and condensers unless extreme care is exercised. Sudden pressures in fire-heated stills are sources of trouble. All safety valves should be steam-heated, and should blow into heated lines which will deliver the discharged materials to a point well isolated from the fires. Disaster has resulted from lack of realization on the part of operators of the suddenness with which naphthalene will block lines.

The Coke Industry and the By-product Oven

COKE is produced in the United States by a group of four industries which are related in the sense that the product is more or less interchangeable, but which are sharply differentiated as to location, methods, equipment and organization. Besides that produced in the familiar beehive and by-product ovens, coke is obtained in the refining of petroleum and in the manufacture of coal gas.

Petroleum Coke

The petroleum coke may be dismissed with a word. In refining crude oil the ultimate residue left in the stills is a porous, carbonaceous solid which is broken up into chunks and thrown out. Its properties are much like those of coke made from coal, except that it is finer in texture and lacks the strength required for metallurgical coke. The best petroleum coke is extraordinarily low in ash, running less than 1 per cent—a quality which adapts it to the manufacture of carbon electrodes. For this purpose it brings a high price—during the war as much as \$18 a ton. Petroleum coke that can not meet the specifications for electrode manufacture is commonly used as boiler fuel about the refinery. The total quantity of petroleum coke produced in 1914, according to the census of manufactures, was 213,777 tons, valued at \$818,889, an average of \$3.83 a ton. In 1917 the output, according to statistics collected by the United States Bureau of Mines, had risen to 539,366 net tons; in 1918 it was 559,663 tons.

Gas Coke

In the coal-gas industry, as in petroleum refining, the coke obtained is a by-product. The process of carbonization is essentially the same as that in by-product ovens, though the type of oven is very different. The coals used are selected for their yield in gas rather than for their coking qualities, and the coke formed is too soft for furnace or foundry use. It is, however, well adapted to the manufacture of water gas, a fact which has led to the common association of coal-gas and water-gas plants as parts of the same city supply. Indeed, of the 3,180,535 tons of gas-house coke produced in 1918, 43 per cent. was used in water-gas manufacture or for boiler fuel about the plant where it was produced. The remainder, 1,814,000 tons, was marketed, largely as domestic fuel, for a total of \$14,022,818.

Neither petroleum coke nor gas-house coke is adapted for metallurgical purposes—the use which consumes over 90 per cent. of all the coke produced. Practically speaking, therefore, the coke trade is concerned only with beehive and by-product coke. Although their product is interchangeable, there are fundamental differences between the beehive and by-product industries which must not be lost sight of. The manufacture of beehive coke is essentially a small-unit industry; that of by-product coke is a large-unit industry.

Beehive Coke

In the beehive industry, the older of the two, the coal is charged into beehive-shaped or rectangular brick

ovens of small capacity and burned with slight access to air, the heat required for coking being furnished by the combustion of the volatile matter and a part of the carbon. The beehive oven is well adapted to pioneering. It can be built in remote mining camps, wherever a seam of coking coal crops out, to supply an infant copper or iron industry. To avoid the cost of transportation on that part of the coal that is not converted into coke, the ovens are located at the mines. There is no recovery of by-products and no general market for the breeze or fines produced. The capital investment per oven is small, and the time required to construct an oven is brief. Each oven is a unit, and coke may be made on any scale, large or small.

Although during the last 30 years there have been large consolidations of beehive operations, notably in the Connellsville district, the incentive to amalgamation was perhaps more the acquirement of reserves of coking coal than the unification of oven operation. The beehive oven is easily started up and as easily shut down. Deterioration from exposure to the elements is small and simply repaired. Producing coal of excellent quality for general use and therefore able to ship coal if not coke, the beehive operator is not confined to coke as his sole source of revenue. All these factors combine to make the overhead charges in beehive operation small and, to adapt the industry to the fluctuating demand which has been a feature of American business.

By-Product Coke

In sharp contrast, the manufacturer of by-product coke typifies large-scale modern industrialism. The by-product plant, with its intricately designed retort ovens, its use of power and machinery, its apparatus for by-product recovery, its tar and benzol stills, is essentially a chemical factory. It must be located near the point where the first among the by-products—the gas—is to be used, ordinarily near some large center of population. Not only are the volatile products in the gas recovered, but maximum efficiency in the utilization of fines and other wastes is possible. The by-product plant requires technical skill of the highest order, large initial investment, and large operating units. All the things mean heavy overhead expenses per ton of coke produced and put a premium on continuous operation.

The two industries have long been in competition. On the continent of Europe beehive coking went out of existence years ago, but in the United States it has persisted, although the good points of by-product ovens are as well known to the beehive operators as to anyone else. In fact, many of the active movers in by-product development have been financially allied with the companies that were producing beehive coke.

Among the causes that have retarded the installation of retort ovens has been the small demand for many of the by-products in America. The ammonia could be easily marketed, but the lack of a dyestuffs industry in America meant small demand for the group of benzol products and low prices for tar. No less important was the absence of markets for gas near the chief centers of steel manufacture. In the Pittsburgh district by-product oven gas had to meet the competition of natural gas, which is superior in heating efficiency and for many years was available in unlimited quantity at exceedingly low prices. The very fact that the population is less dense in the United States than in Europe operated to discourage the recovery of by-products here. Moreover, the violent fluctuations in the production of iron and steel and consequently in the demand for coke, more marked in the United States than in Europe, were less of a handi-

cap to the beehive industry, with its low overhead charges, than to the by-product plants, where continuous operation was essential to profits. Not least among these forces has been the prodigality of the Nation's resources in fuel, which made it cheaper to mine more coal than to use efficiently that already mined.

In the equilibrium between beehive and by-product manufacture an influence of great potentiality is the relative freight rate on coke and on raw coal. The average ton of beehive coke represents only 70 per cent. of the weight of the coal necessary to make the same coke in a by-product oven. Therefore, merely to equalize transportation costs, beehive coke can stand a considerable freight differential in excess of coal. In recognition of this fact rates on coke have generally been higher than those on coal. Any disturbance of existing differentials between coal and coke rates would tend to alter the terms of competition between beehive and by-product coke.

By-Products Obtained from Coke-Oven Operations in 1920 (Preliminary Figures Geological Survey, subject to revision)

Product	Unit	Production	Sales	Val. of Sales
Tar	Gallons	360,000,000	172,000,000	\$7,404,000
Ammonia:				
Sulphate	Pounds	675,000,000	629,000,000	27,150,000
Ammonia liquor and anhydrous ammonia (a)	Pounds NH ₃	65,000,000	63,000,000	8,300,000
Total sulphate equivalent	Pounds	935,000,000	881,000,000	35,450,000
Gas (b)	M cu. ft.	476,000,000	227,000,000	32,050,000
Benzol products:				
Crude light oil	Gallons	109,000,000	843,000	96,000
Benzol, crude	Gallons	8,960,000	1,730,000	430,000
refined	Gallons	16,890,000	15,580,000	4,030,000
motor fuel	Gallons	55,100,000	53,200,000	12,070,000
Toluol, crude	Gallons	287,000		
refined	Gallons	2,740,000	2,490,000	760,000
Solvent naphtha	Gallons	5,420,000	4,530,000	820,000
Napthalen:				
crude	Pounds	10,710,000	10,750,000	290,000
refined	Pounds	3,450,000	3,700,000	200,000
Other products*				30,000

Total value \$93,626,000
(a) Includes anhydrous ammonia reported as such, and ammonia liquor converted to equivalent in anhydrous ammonia. Of this, the quantity sold in the form of ammonia liquor was equivalent to 19,000,000 pounds NH₃.

(b) Of the 476,000,000 M of gas produced, 237,000,000 M was used in heating coke ovens, and 12,000,000 M was wasted. The distribution of the 227,000,000 M shown as "sold" was as follows:

	M. cu. ft.	at Plant
Used under boilers or other coke plant equipment	24,000,000	\$2,150,000
Used in steel or other affiliated plant.....	150,000,000	14,200,000
Distributed through city mains	53,000,000	15,700,000

227,000,000 \$32,050,000
(c) The quantity of crude light oil reported refined on the premises was 106,000,000 gallons.

(d) The percentage of benzol reported in the motor fuel ranged from 50 to 90.

(e) Includes coal tar, crude heavy solvent, retort carbon, pyridin oil, etc.

The table above summarizes reports received by the Geological Survey from operators of by-product coke ovens covering the year 1920. The statistics are subject to revision on receipt of final reports from two companies for which at present complete information is not available. The total value of the by-products sold including gas used about the works for other purposes than heating by-product ovens was \$93,626,000.

To recover these by-products required the carbonization of 44,224,000 net tons of coal. The quantity of merchantable coke produced was 30,781,000 tons, indicating a yield of coke from coal of 69.6 per cent. In addition, the operators reported a recovery of 2,322,000 tons of screenings and breeze. The yield of coke including breeze was 74.9 per cent of the coal charged.

Average Recovery Per Net Ton of Coal Charged Into By-Product Ovens in 1918, 1919 and 1920.

	1918	1919	1920
NH ₃ (all forms) expressed in terms of equivalent ammonium sulphate.....	Pounds..... 18.9	20.8	21.2
Tar	Gallons..... 7.1	8.1	8.1
Crude light oil	Gallons..... 2.4	2.7	2.5
Gas	M. cu. ft..... 10.4	11.6	10.8

American By-Product Coke-Oven Installations

Owner or Operator—Location	Number of Ovens	Kind of Ovens	Annual Capacity, Net Tons	
	ALABAMA		Coal	Coke
Alabama By-Products Corporation, Birmingham.....	50	Koppers	335,000	235,000
Gulf States Steel Co., Alabama City.....	37	Koppers	237,000	175,000
Tennessee Coal, Iron & Railroad Co., Ensley.....	240	Semet-Solvay	760,000	530,000
Central Iron & Coal Co., Tuscaloosa.....	60	Semet-Solvay	290,000	220,000
Stess-Shufeldt Steel & Iron Co., Birmingham.....	120	Semet-Solvay	864,000	622,000
Tennessee Coal, Iron & Railroad Co., Fairfield.....	434	Koppers	2,560,000	1,920,000
Woodward Iron Co., Woodward.....	200	140 Koppers, 60 Wilputte (30 Koppers being rebuilt).....	1,330,000	997,200
COLORADO				
Colorado Fuel & Iron Co., Minnekahta.....	120	Koppers	720,000	550,000
ILLINOIS				
Chicago By-Product Coke Co., Chicago.....	100	Koppers building	667,000	437,000
Coal Products Mfg. Co., Joliet.....	53	35 Koppers, 18 Wilputte.....	340,000	238,000
Illinois Steel Co., Joliet.....	280	Koppers	1,500,000	1,200,000
International Harvester Co., South Chicago.....	88	Wilputte	578,000	376,000
North Shore Gas Co., Waukegan.....	13	Semet-Solvay	55,000	38,500
St. Louis Coke & Chemical Co., Granite City.....	80	Roberts	400,000	250,000
By-Products Coke Corporation, South Chicago.....	280	Semet-Solvay	1,300,000	975,000
INDIANA				
Central Indiana Gas Co., Muncie.....	22	Klonne	40,000	28,000
Citizens' Gas Co., Langsdale.....	41	Semet-Solvay	255,000	182,900
Citizens' Gas Co., Prospect.....	140	100 United-Otto, 40 Wilputte.....	567,000	409,400
Illinois Steel Co., Gary.....	790	Koppers	4,400,000	3,480,000
Indiana Coke & Gas Co., Terre Haute.....	60	30 Gas Mach., 30 Koppers.....	292,000	205,000
Inland Steel Co., Indiana Harbor.....	130	Koppers	890,000	666,000
Linton Gas Co., Linton.....	3	Gas Mach.	15,000	9,300
Steel & Tube Co., Indiana Harbor.....	120	Semet-Solvay	864,000	622,000
KENTUCKY				
Kentucky Solvay Coke Co., Ashland.....	108	Semet-Solvay	864,000	648,000
MARYLAND				
Bethlehem Steel Co., Sparrows Point.....	360	Koppers	2,190,000	1,576,000
MASSACHUSETTS				
New England Fuel & Trans. Co., Everett.....	400	United-Otto	650,000	455,000
MICHIGAN				
Ford Motor Co., Dearborn.....	120	Semet-Solvay	864,000	622,000
Michigan Alkali Co., Wyandotte.....	70	United-Otto	169,200	118,400
Semet-Solvay Co., Detroit.....	215	Semet-Solvay	1,343,000	1,009,000
MINNESOTA				
Minnesota By-Product Coke Co., St. Paul.....	63	Koppers	490,000	300,000
Minnesota Steel Co., Duluth.....	90	Koppers	600,000	450,000
Zenith Furnace Co., West Duluth.....	65	United-Otto	160,000	112,000
MISSOURI				
Laclede Gas Light Co.....	56	Koppers (8 Plette-building).....	320,000	240,000
NEW JERSEY				
Camden Coke Co., Camden.....	100	United-Otto (37 Koppers building).....	240,000	68,100
Seaboard By-Product Coke Co., Kearny.....	165	Koppers	1,200,000	900,000
NEW YORK				
Donner-Union Coke Corporation, Buffalo.....	150	Koppers	1,000,000	650,000
Empire Coke Co., Geneva.....	45	Semet-Solvay	146,000	102,200
Lackawanna Steel Co., Lackawanna.....	530	188 United-Otto, 282 Rothberg, 60 Semet-Solvay	1,350,000	972,000
Semet-Solvay Co., Solvay.....	40	Semet-Solvay	65,000	45,000
Wickwire Steel Co., Buffalo.....	60	Semet-Solvay	386,000	289,500
OHIO				
American Steel & Wire Co., Cleveland.....	180	Koppers	1,080,000	750,000
Brier Hill Steel Co., Youngstown.....	84	Koppers	520,000	379,000
Hamilton-Otto Coke Co., Kokotto.....	100	United-Otto	240,000	168,000
McKinney Steel Co., River Furnaces.....	204	Koppers	1,300,000	960,000
National Tube Co., Lorain.....	208	Koppers	1,200,000	850,000
Penn Iron & Coal Co., Canal Dover.....	24	Roberts	144,000	100,000
Republic Iron & Steel Co., Youngstown.....	143	Koppers	1,020,000	744,600
Otis Steel Co., Cleveland.....	100	Semet-Solvay	450,000	337,500
Ironton Solvay Coke Co., Ironton.....	60	Semet-Solvay	432,000	311,000
Portsmouth-Solvay Coke Co., Portsmouth.....	108	Semet-Solvay	770,000	559,000
Toledo Furnace Co., Toledo.....	94	Koppers	560,000	408,800
United Furnace Co., Canton.....	47	Koppers	280,000	204,400
The Youngstown Sheet & Tube Co., Youngstown.....	306	Koppers	2,050,000	1,425,000
PENNSYLVANIA				
Allegheny By-Product Coke Co., Glassport.....	120	United-Otto	260,000	195,000
Bethlehem Steel Co., Bethlehem.....	424	Koppers	2,400,000	1,920,000
Bethlehem Steel Co., Lebanon.....	90	Semet-Solvay	640,000	465,000
Bethlehem Steel Co., Steelton.....	180	120 Semet-Solvay, 60 Koppers.....	876,000	621,500
Cambria Steel Co., Franklin.....	492	210 United-Otto, 92 Koppers, 190 Cambria-Belgian	1,822,000	1,226,000
Cambria Steel Co., Rosedale.....	60	Cambria-Belgian (60 Cambria-Belgian building, 885 Semet-Solvay building).....	*286,000	192,000
Carnegie Steel Co., Clairton.....	768	Koppers	4,800,000	3,360,000
Carnegie Steel Co., Farrell.....	212	United-Otto	830,000	581,000
Jones & Laughlin Steel Co., Pittsburgh.....	300	Koppers	2,000,000	1,300,000
Philadelphia Suburban Gas & Electric Co., Chester.....	40	Semet-Solvay	125,000	87,500
Pittsburgh Crucible Steel Co., Midland.....	100	Koppers	667,000	435,000
Rainey Wood Coke Co., Swedeland.....	110	Koppers	800,000	600,000
American Manganese Mfg. Co., Dunbar.....	110	Semet-Solvay	248,000	173,000
RHODE ISLAND				
Providence Gas Co., Sassafras Point.....	40	Koppers	240,000	165,000
TENNESSEE				
Chatanooga Coke & Gas Co., Alton Park.....	24	Semet-Solvay	175,000	125,000
WASHINGTON				
Seattle Lighting Co., Seattle.....	20	Klonne	24,000	13,000
WEST VIRGINIA				
Domestic Coke Corporation, Fairmont.....	60	Koppers	400,000	260,000
La Belle Iron Works, Follansbee.....	94	Koppers	610,000	445,000
National Tube Co., Benwood.....	120	Semet-Solvay	270,000	189,000
WISCONSIN				
Milwaukee Coke & Gas Co., Milwaukee.....	160	Semet-Solvay (150 Koppers building).....	750,000	562,500
Steel & Tube Co. of America, Mayville.....	108	United-Otto	1,080,000	864,000

Licensed Manufacturers of Arsphenamine

The surreptitious sale in New York of spurious arsphenamine has impelled the U. S. Public Health Service to issue a warning against unscrupulous vendors. Analysis of a fraudulent substitution by the New York City Department of Health disclosed it to be a combination of sodium chloride and a yellow dye. The U. S. Public Health Service says:

"Your attention is invited to the extensive exploitation, through advertisements in professional journals and otherwise, of various arsenic preparations which are not related to the arsphenamine group. The preparations referred to are sold with claims in regard to their value in the treatment of syphilis which are unwarranted.

"In the opinion of this office it is in the interest of all concerned that the subcutaneous, intramuscular, or intravenous use of arsenic in the treatment of syphilis be confined to preparations of the arsphenamine group, as these agents are of established value and are produced under the regulations of the Public Health Service. The following firms are now licensed for the manufacture of arsphenamine and neo-arsphenamine: Dermatological Research Laboratories, 1720 Lombard Street, Philadelphia, Pa.; H. A. Metz Laboratories, 122 Hudson Street, New York, N. Y.; Diarsenol Co., Inc., Buffalo, N. Y.; Takamine Laboratories, Clifton, N. J.; Squibb & Sons, New Brunswick, N. J.; Farbwerke Hoechst, vorm. Meister Lucius & Bruening, Hoechst-am-Main, Germany; Poulenc Frères, 92 Rue Vieilledu-Temple, Paris, France.

The Lowy Laboratory, of Newark, N. J., has been granted a license to prepare a stable solution of arsphenamine.

Growing Sensitiveness of the Commercial Conscience

The United Indigo & Chemical Company, Ltd., a British corporation with offices in Boston, is required by a recent order of the Federal Trade Commission to refrain from certain competitive methods in the chemical industry.

The order issues after trial of formal complaint by the commission and requires this firm to discontinue the practice of giving sums of money and other gifts and entertainment to employees of its customers and to employees of its competitors' customers as inducements to persuade such employees to recommend to their employers the purchase of dyestuffs, chemicals and other dyeing goods and products from the United Indigo & Chemical Company, Ltd., and also to refrain from purchasing such products from competitors of that firm.

Testimony was given at the trial that during the three-year period, 1916, 1917, 1918, the United Indigo & Chemical Company, Ltd., expended for entertainment and gratuities to employees of its customers and competitors' customers an average of from \$40,000 to \$50,000 per year.

These gifts were found to have been given without the knowledge or consent of the employers whose employees received the goods. This practice has been declared by the commissioners an unfair method of commerce, and its discontinuance ordered.

* * *

H. Foster Bain, director of the Bureau of Mines, has issued an order which virtually closes the Government helium plant at Petrolia, Texas. Lack of funds and the necessity for economy are given as reasons for shutdown.

American Valuation of Imported Goods

Editor, CHEMICAL AGE:

Due to depreciation of foreign currency at this time as a result of the world war it is impossible to impose a fair and just ad valorem duty on imports, using the foreign market value. This can best be understood by taking the German mark as an example.

In 1914 the German mark, as measured in United States money, was worth approximately 24 cents. Now it is worth 1.3 cents. A duty of 33 1-3 per cent, imposed in 1914 on a Germany product having a foreign value of 200 marks would amount to \$11.90. Today, owing to depreciation of the German mark, the same duty would amount to only about 65 cents.

The Japanese yen, on the other hand, has not depreciated to the same extent. A yen in 1914 was worth about 50 cents and today it is worth 48 cents.

If an ad valorem duty were imposed upon German goods at this time at a rate sufficient to give protection to American industry it doubtless would be absolutely prohibitive against Japanese goods as well as against goods from Great Britain and other countries whose currency has not depreciated to the same extent.

Industry does not want a prohibitive tariff. It is simply seeking a tariff sufficient to secure a differential between labor costs here and labor costs abroad so that present standard of living conditions for the American working man and woman may be maintained in this country.

If an ad valorem duty be based upon the foreign value then the country whose cost of production is lowest and whose profits are therefore the greatest pays the smallest amount of duty. This is obvious because the lower the foreign value the less the duty at any given rate if such rate is applied upon the foreign value.

American value, as incorporated in the new Fordney tariff bill, on the other hand, for all foreign products that are comparable regardless of the country from which they come, is substantially the same, so that if the rate is applied upon the American value each country importing the same product will be charged the same amount of duty. This is desirable because there is no good reason for discriminating against those countries whose costs of production are more comparable to such costs in this country.

J. F. ZOLLER, General Electric Co.

The fixed nitrogen laboratory of the War Department was transferred July 1 to the Department of Agriculture together with \$500,000 appropriation, which is regarded as sufficient to maintain the laboratory for two years. Col. Burns of the War Department Nitrate Division is a firm believer in the future of atmospheric nitrogen and its uses, but he is convinced that this lies in agriculture.

* * *

Circular No. 131 of the Institute of Paint and Varnish Research by a Henry A. Gardner is devoted to the consideration of paints for "light oil" storage tanks, wherein are given data showing the loss by evaporation of petroleum distillates contained in small tanks painted in various colors. It is shown that dark colors cause high evaporation losses which may be greatly reduced by the application of light colored paints. Information is also given as to the type of pigments for a non-darkening paint to be used on oil tanks in districts where sulphur compounds are present in the air. A special investigation of new type spray apparatus for tank painting has been made, and the results transmitted in illustration and text matter.

The American Asphalt Industry

By Prévost Hubbard

Chemical Engineer, The Asphalt Association



PRÉVOST HUBBARD
Chemical Engineer, The Asphalt
Association

PRIOR to 1902 the term "asphalt" was confined almost exclusively to certain semi-solid or solid bitumens which were found in natural deposits most of which occurred in admixture with clay, silt or vegetable matter which could not be removed by ordinary refining methods when the mineral matter predominated the product was termed asphaltic sand or rock asphalt depending upon whether or not the mineral structure was loosely or firmly knit together.

Trinidad and Bermudez Asphalts

No appreciable tonnage of asphalt was used in this country until 1883 when about 35,000 tons were imported mainly from Trinidad and found

its way into the paving industry. Prior to this, relatively small quantities of Trinidad asphalt and certain European rock asphalts or bituminous limestones had been used in the construction of pavements in a few American cities. As most of the European rock asphalts contain less than 15 per cent. of asphalt proper, while the refined Trinidad asphalt uniformly carries about 56.5 per cent. of bitumen they eventually were unable to compete successfully with the latter, and until 1892 Trinidad asphalt was used to such greater extent that, in most minds, the term "asphalt" came to mean Trinidad asphalt.

In 1892 a relatively pure asphalt deposit occurring in Venezuela and known as Bermudez Lake asphalt was exploited in small quantities and this product began to find its way into the United States where it also was used in pavement construction. From this time on Trinidad asphalt was obliged to share honors with Bermudez asphalt, the importation of which gradually increased until at the present time it is nearly equal in tonnage to the Trinidad asphalt. Other foreign asphalts occurring in Venezuela, Cuba and elsewhere have appeared temporarily on the American market but never in any great quantity.

Native Asphalts

Large deposits of asphaltic sands and rock asphalt have been found in this country but their development has been limited as many are unsuited for present industrial purposes. Comparatively small deposits of very hard and nearly pure asphalt commonly known as Gilsonite, Uintaite, Grahamite and Wurtzilite have also been discovered in various parts of the United States and have been found particularly well suited for the manufacture of asphalt specialties. Their combined available tonnage, however, has been so small that their use in the two main asphalt industries, paving and roofing, has been very limited.

Practically all native asphalt is too hard for direct use in the manufacture of asphalt products and after a simple refining process which consists in heating the crude material until water, gas and other volatile material are driven off, it must be softened to suitable consistency by combining it with the proper amount of residual petroleum known as "flux oil." Petroleum therefore always serves as an important integral part of all asphalt used for industrial purposes. For many years it was believed, and it is now generally admitted, that all asphalt originates in petroleum.

Petroleum Asphalt

The petroleum first known and used in the United States, occurring in Pennsylvania, Ohio and Indiana, was of the paraffin type. When distilled to remove the more volatile constituents this petroleum was found to yield a thick greasy residue which in no way resembled asphalt except in color but which proved quite satisfactory for use as a flux. If distillation was carried further this residual oil underwent certain chemical changes due to cracking of the hydrocarbon constituents and eventually coke remained in the still.

As early as 1865 it was known that bituminous material was susceptible to the action of certain oxidizing agents which caused the product to become more viscous, and in 1894 Francis X. Byerley was granted a patent for blowing air through petroleum residues when heated to between 400° and 600° F. By this process it was found possible to produce a semi-solid residue which in some ways resembled the native asphalts but which, with the type of oil used, was more or less cheesy in character and lacked the cementitiousness of the then known asphalt. This product was marketed as Byerlyte asphalt but never found much favor in the paving industry because of the inferior results attending its use. It was found, however, that when so treated, residual oils from petroleum occurring in the Gulf section yielded a better grade of product than the more highly paraffin type of petroleum.

With the discovery and refining of California petroleum it was observed that when the residual oil was distilled further and before coke was formed, a semi-solid residue was produced which very closely resembled the native asphalts. The original petroleum therefore was called asphaltic petroleum. The asphalt first manufactured from this type of petroleum proved to be of rather inferior quality, the cause of which was shown later to be due to the high temperatures required to drive off a sufficient amount of oil constituents to produce a semi-solid residue. At such temperatures the hydrocarbons began to crack up with the formation of undesirable decomposition products. Later it was found that if distillation was conducted with a copious amount of steam, used to agitate the contents of the still, cracking largely could be prevented, as the volatile products were removed at a much lower temperature. This discovery not only assured a larger future supply of high-grade asphalt from domestic sources but conclusively proved that asphalt originates in certain petroleum; that it is actually held in solution in such petroleum; and that when recovered by suitable means it essentially is the same as certain native asphalts.

Growth of Petroleum Asphalt Industry

By 1902 petroleum asphalt was on the American market in appreciable quantities, about 20,000 tons being manufactured during that year. It found its way into the paving industry where it was received on trial for a number of years until service over a considerable period of time demonstrated that it was equally as good for paving work as the lake asphalts. By 1911 the tonnage of asphalt produced from domestic petroleum exceeded the importation of Trinidad and Bermudez asphalt and from that time on the production from this source has grown rapidly.

In 1913 large quantities of Mexican petroleum found its way into the United States. This petroleum is highly asphaltic in character and when subjected to steam distillation yields a much higher percentage of asphalt than any petroleum found in the United States. About 100,000 tons of asphalt were produced in 1913 from this source as compared with about 230,000 tons of imported native asphalt and over 400,000 tons of asphalt produced from domestic petroleum. This year showed the peak of importation of native asphalt which was at that time equal to only a little more than two-fifths of the total production from petroleum. From that time on there has been a general decline in importation of lake asphalt with a very rapid increase in asphalt distilled from petroleum.

The growth in asphalt tonnage from Mexican petroleum has been even more remarkable than from domestic petroleum and since 1918 has exceeded the latter. Statistics of the U. S. Geological Survey for 1919* which are the latest ones available show the following:

Asphalt from domestic petroleum.....	614,692	tons	41.4%
Asphalt from Mexican petroleum.....	674,876	"	45.5%
Domestic native asphalt (bituminous rock)	53,589	"	3.6%
Other domestic native (bituminous substances)	34,692	"	2.3%
Asphalt imported from Trinidad and Tobago	51,062	"	3.5%
Asphalt imported from Venezuela.....	47,309	"	3.2%
Other imported asphalts including bituminous rock.....	7,277	"	.5%
Total.....	1,483,497		100%
**Asphalt exported from the U. S.....	40,208		

Approx. consumption of asphalt in U. S., 1,443,289

From this table it is seen that nearly 87 per cent. of all asphalt produced by or imported into this country is obtained from the distillation of petroleum. If the mineral and other extraneous matter in rock asphalt and Trinidad and Bermudez asphalt are eliminated a conservative estimate would raise the proportion of petroleum asphalt to over 92 per cent. of the total, leaving about 1.4 per cent. Trinidad bitumen and 3.2 per cent. Bermudez. The fact that the bitumen of lake asphalt now constitutes less than 5 per cent. of the total asphalt consumed by the United States may be surprising to the many who heretofore have considered the lake asphalts as the most important.

Asphalt Tests and Definitions

The generally accepted description of asphalt as regards its consistency or hardness is that it is a semi-solid or solid. The principal test for consistency is known as the penetration test and is ordinarily made by determining the distance that a standard needle will penetrate a sample of asphalt when it is maintained at 25° C., the needle being loaded with a given weight and the load being applied for a given length of time. The depth which the needle penetrates is expressed in units

of 0.1 mm. each. Unless otherwise indicated the load is considered to be 100 grams and the time of application 5 seconds.

There is no distinct line of demarcation between a fluid and a semi-solid but the American Society for Testing Materials has adopted the following arbitrary definition which may serve as a rough division between asphalts and fluid residual petroleum products.

"Liquid Bituminous Materials: Those having a penetration at 25° C. (77° F.) under a load of 50 grams applied for 1 second of more than 350." Materials which under this test show a penetration of less than 350 but more than 10 when tested at the same temperature with a load of 100 grams for 5 seconds are classed as semi-solids. If the material shows a penetration of less than 10 when tested as last described it is called a solid. Road oils and some fluxes may be classed as liquids under these definitions and therefore not asphalts. The heavier and more viscous fluxes, however, would be classed as asphalts. The Geological Survey in its 1919 report has made no distinction between asphaltic materials with reference to use or consistency so that the figures previously quoted include some tonnage of what may be classed as liquid asphaltic products. In fact such products are sometimes marketed under the name of liquid asphalt owing to the very high percentage of asphalt which is held in solution by the oily constituents which are present.

Asphalt-Content of Petroleum

The highly asphaltic crude petroleum sometimes carry such a large proportion of asphalt that this product becomes of primary importance in refining. This is particularly true of Mexican petroleum from the heavier grades of which over 70 per cent. of asphalt of 100 penetration may be obtained by steam distillation. Heavy California asphalt may by the same process yield as high as 50 per cent. of asphalt of the same penetration. From other domestic petroleum it is impracticable commercially to recover asphalt unless the blowing process is employed or the fluid residual petroleum is first subjected to a carefully controlled cracking process under pressure. In some cases, however, the other domestic crudes are utilized in the manufacture of asphalt by mixing them with Mexican crude before distillation.

In spite of the large tonnage of asphalt produced from domestic petroleum, its manufacture from this source constitutes only a very small part of the petroleum industry. The specific gravity of domestic petroleum asphalt averages about 1.01 or 8.4 pounds per gallon. On this basis the volume of domestic petroleum asphalt for 1919 amounts to about 146,000,000 gallons as against approximately 15,846,000,000 gallons of crude oil or less than one per cent. by volume of crude. Mexican oil asphalt averaging 1.04 specific gravity shows about 155,000,000 gallons for 1919 as against approximately 2,218,000,000 gallons of Mexican crude oil, or about 7 per cent. When it is considered that practically all Mexican petroleum is highly asphaltic in character these figures show the possibility of increase in asphalt production from this source to be very great as the demand increases. At the present time an enormous quantity of asphalt present in crude petroleum and many times greater than the amount actually produced is not being recovered but is burned as fuel oil.

Properties and Uses

Asphalt is the oldest waterproof adhesive known to man and since its production from petroleum has made it readily available in large quantities it has been adapted

*This does not include monometallics of asphalt which are valued at approximately one-half the value of the tonnage of asphalt exported. Asphalts and Related Bitumens in 1919 by R. W. Cottrell.

for a surprising number of industrial purposes. Of these the paving industry consumes the greatest proportion. The probable consumption of asphalt of 190 penetration and less in pavement construction and maintenance during 1921 has been estimated by J. E. Pennybacker, Secretary of the Asphalt Association to be about 634,000 tons. To this may be added about 35,000 tons of flux, necessary to soften the harder grades to suitable consistency, giving a grand total of 669,000 tons. Allowing 10 per cent. for maintenance this amount will be sufficient to construct about 60,000,000 square yards of asphalt pavement or on the basis of a 20-foot width over 5,000 miles of such pavement.

In the consumption of asphalt the roofing industry is a close second to the paving industry and together they consume probably 90 per cent. of the entire asphalt output, if road oils are not included. The development of the asphalt roofing industry to sizeable proportions has been more recent than the paving industry but was given a great impetus during the late war period owing to the enormous demand for ready and prepared roofings. Herbert Abraham, Chairman of the Technical Committee of the Prepared Roofing Association, estimates the present annual consumption of asphalt, including flux, by the roofing industry to be about 625,000 tons equivalent to 28,375,000 squares of roofing. Figuring an average of about 10 squares to a dwelling this amount is sufficient to cover more than 2,500,000 dwellings or over 280,000,000 square yards of roof.

In addition to paving and roofing there are a large number of industries which in the aggregate consume about 144,000 tons of asphalt. A considerable amount of this is used for waterproofing and flooring and lesser amounts for sheathing and insulating purposes. Asphalt also finds its way into the manufacture of considerable quantities of paints, varnishes, enamels and

japans, and such specialties as anti-acid compounds, pipe dips, bituminous putty or cement, emulsions, moulding compositions, electrical insulating products, sealing compounds for storage batteries, wall boards and floor coverings.

In most finished products asphalt is used primarily as a binder or coating for the body of the structure and constitutes but a fraction of the total weight of such products. Its use is therefore dependent upon the consumption of large quantities of other materials, the production of which represents industries dependent to a considerable extent upon the asphalt industry. Thus in pavement construction considering only that portion of the pavement which is bound together with asphalt an average of about 8 per cent. of asphalt is used to bind 92 per cent. of mineral aggregate. This represents an annual consumption of over 8,000,000 tons of broken stone, gravel and sand in pavement construction including nearly 400,000 tons of pulverized limestone or Portland cement filler. The manufacture of asphalt roofings probably consumes in the neighborhood of 200,000 tons of felt and similar fabrics and 300,000 tons of mineral surfacing such as talc, mica, silica, sand and crushed rock.

Without considering the various materials used in asphalt specialties a rough approximation of material annually consumed in the manufacture of asphalt products, including pavements, would be as follows:

Paving asphalts and fluxes.....	669,000 tons
Roofing asphalt and fluxes.....	625,000 tons
Asphalt for specialties.....	144,000 tons

Total asphalt not including road oils.....	1,438,000 tons
Sand, gravel, and crushed rock for paving.....	8,000,000 tons
Mineral surfacing for roofing.....	300,000 tons
Felted and other fabric for roofing.....	200,000 tons

Grand total.....9,938,000 tons

Lithopone Production and the Zinc Industry

By J. F. Williams, Jr.

Secretary, in Charge of Plant Development and Operations, Collinsville Zinc Co.

LITHOPONE is a pure white pigment, chemically a combination of precipitated sulphide of zinc and sulphate of barium.

Origin of Manufacture

It was first discovered or made about fifty years ago in England, but as its value was not recognized, its manufacture was not attempted for some years. Germany, first recognizing its possibilities, manufactured lithopone for many years before it was produced in any other country. France next took it up, but in the early days the industry never reached any importance in that country. This is surprising when we consider the fact that the French Government fostered the zinc industry, owing to the tax or royalty paid to the French Government on all productions of zinc. England was probably the next country to attempt its manufacture, but there is reason to believe that this was partially due to the English desire to become independent of German importations rather than to any great belief in the future of the industry. A certain amount of lithopone was manufactured in Spain at about the same time that it appeared in England.*

Domestic Enterprise

In the United States lithopone was first manufactured about 1900, but the industry was not of suffi-

cient importance to call for a specific report on the tonnage produced or used in the United States until 1906, when the U. S. Geological Survey reported a consumption of 4,300 tons. Prior to this the Geological Survey had reported only that such a product was being made in a small way.

The early manufacturers in the United States were all located on the Eastern seaboard. This was possibly due to the fact that Germany was the only real producer and that the Eastern manufacturer of paints was more favorably situated to obtain an imported pigment than those located farther West.

In the early manufacture of lithopone in the United States many difficulties were encountered. At least three concerns in the East attempted its manufacture, but finally they were compelled to import German chemists and methods before obtaining even fairly satisfactory results.

This had two effects: First, to discourage any great development in the United States, and, second, to lead to almost slavish copying of German methods in the manufacture in this country, through fear of obtaining unsatisfactory results.

German methods, however, were absolutely unsuitable to conditions in this country, their practice being that of very small units and the absence of labor-saving devices. It was not until 1910 to 1915

*Presented at annual meeting of the American Zinc Institute, Inc., May 9-10, St. Louis, Mo.

that the demand in the United States actually justified a real and serious development of the industry.

As it requires about 400 tons of raw material, such as zinc, barytes, sulphuric acid, coal, cooperage and miscellaneous chemicals, to manufacture 100 tons of lithopone, the logical location for a plant is not on the Eastern sea coast, with its high coal cost, long haul on zinc and cooperage, etc., but a location near the great zinc and barytes fields of the middle West and their adjacent coal fields, and it is in this section that future development of the industry must come.

At the present time lithopone is manufactured in one plant in Baltimore, two in the Philadelphia district, two in New Jersey, one in Delaware, two in the Chicago section, two in the St. Louis district, one on the Pacific Coast and one in Indiana.

American methods of manufacture, labor-saving devices, large units and new methods are rapidly revolutionizing the industry.

Many people attribute the great increase in the industry in this country in the past few years to the war and to the cessation of importations, but as importations have never exceeded 16 per cent. of the consumption in the United States, and since 1906 have averaged less than 10 per cent., this is hardly a fair conclusion, and the more reasonable analysis shows that the increase in production and consumption has been due to the general recognition of lithopone's value as a pigment and for other uses.

Properties and Uses

Considering its relatively recent origin as compared with the other two great pigments, white lead, which has been known for two thousand years, and zinc oxide, which has been known for one hundred and fifty years, we must bear in mind that lithopone has hardly yet had time to be fully tested in many industries. It takes many years to introduce a new pigment, as the large paint grinders will not adopt a new pigment until it has been tested and proven under all sorts of varying conditions. The almost universal adoption of lithopone as a pigment, therefore, in really about ten years' actual use, speaks eloquently of its merit.

Lithopone is used extensively in the manufacture of paints, either simply ground in oil and tinted, or mixed with other ingredients. It is also used largely in the manufacture of rubber goods, such as automobile tires, rubber matting, etc.; also in the manufacture of oil-cloth, linoleum, window shade cloth; also, to a smaller extent, in printers' ink, face powder, etc.

Its most important use is undoubtedly in the manufacture of paints. For some years regarded as an adulterant or substitute for white lead or zinc oxide, its excellent qualities as a pigment coupled with improvement in its manufacture has rapidly led to its being recognized as a pigment of exceptional value. For interior use, in flat wall tints, it has long been recognized as being superior to white lead or zinc oxide. For outside work, it was for many years unsuitable in white and light-colored tints, owing to what are known as its photogenic properties. These caused it to discolor when exposed to the direct rays of the sun. This discoloration would cause a darkening of the white pigment, and it would turn to a light or dark gray, according to its method of manufacture. This dark color would again fade when the pigment was removed from the light, but never completely. In recent years improved methods of manufacture have eliminated this objectionable feature, opening to lithopone the entire field of outside paints.

In the actual manufacture of paints it has many ad-

vantages over both white lead and zinc oxide. It requires less grinding in oil, being more miscible, for some uses a simple mixing being all that is required. It does not chalk, check or crack or turn yellow with age; it spreads very evenly and has excellent opacity, covering and tinting capacity. It is more cheaply manufactured than either white lead or zinc oxide, and, as the price of lead and zinc increases, this advantage will be enhanced and will further stimulate the use of lithopone.

The zinc enters into its composition in the form of zinc sulphide, and neither this nor the barium sulphate are affected by ordinary acids, alkalies or by sulphur fumes or other customary gases. Zinc sulphide is more permanent and lasting than zinc oxide and is one of the best white pigments known, but difficult and costly to manufacture except in lithopone.

Lithopone is not poisonous, as is white lead, and not injurious to the workmen making or using it. This fact some years ago led to laws being passed restricting the use of white lead abroad, notably in France, and gave a great impetus to lithopone.

While some manufacturers of paints claim that lithopone is the best pigment, a careful review of the conditions under which all pigments are used leads to the belief that white lead, zinc oxide and lithopone each have qualities superior for special uses to either of the others; but the fact remains that lithopone has fewer disadvantages than either of the others and that its use is increasing far more rapidly than that of either zinc oxide or white lead.

In the manufacture of rubber goods, such as automobile tires, rubber matting, fruit jar rings, rubber toilet articles, tubing, etc., it is used as a filler, and also for the curative effect the zinc sulphide has on the rubber, and for this use zinc sulphide is far superior to zinc oxide. This is perhaps best illustrated by the fact that in the manufacture of the highest grade of rubber, medicinal sheeting, dental rubber, pure zinc sulphide is used.

Lithopone and ground cork are used as a base in linoleum. In shade cloth it is used as a filler, to make the cloth impervious to light. In printers' ink it is used as a non-corrosive inert filler, etc.

While probably not conscious of it, we are continually seeing lithopone both in our homes and out in the white oilcloth on the kitchen table, in the linoleum on the floor, in the white enamel in the bathroom, on the flat walls and ceiling tints, in our window shades and in all rubber goods in our houses; also in our automobile tubes and casings, in our rubber coats and rubber overshoes, in the printers' ink on the morning and evening paper; also in much of the painting on our houses. All of these contain lithopone, and it is by no means one of the least important ingredients entering into their manufacture.

As normally manufactured, lithopone contains 30 per cent. zinc sulphide and 70 per cent. barium sulphate, these being approximately the proportions obtained by precipitation of normal barium sulphide and zinc sulphate solutions.

For certain purposes, a lithopone is required having a higher percentage of zinc sulphide, and this can be obtained by adding to the barium sulphide solution a sodium sulphide solution. This will precipitate zinc sulphide from the zinc sulphate solution and leave sodium sulphate, which is soluble and can be washed out. Or by adding zinc chloride to the zinc sulphate solution, which, with the barium sulphide, will precipitate an excess of zinc sulphide and leave barium chloride, which is also soluble and can be washed out.

The percentage of zinc sulphide can thus be regulated as required.

Lithopone Manufacture

In the preparation of the zinc sulphate solution, slab zinc, zinc dross, skimmings, ash or roasted blende or zinc oxide is dissolved in dilute sulphuric acid of about 20 degrees Be. strength. This solution is neutralized, filtered to remove any insoluble residue and then carefully purified and refiltered. This purification is one of the most important steps in the manufacture of high-grade lithopone, and there is probably more variation in this process, in various plants, than in any other one step in the manufacture. High-grade white lithopone cannot be made unless practically pure zinc sulphate solutions are obtained. Broadly speaking, the purification consists of using some powerful oxidizing agent to precipitate iron and other metallic sulphates, filtering, and then boiling with zinc dust to remove cadmium and cobalt, and refiltering. The various foreign metals must be removed, as almost infinitesimal traces of iron, cadmium, cobalt, copper, etc., will discolor the finished product.

In preparing the barium sulphide solution, barytes (sulphate of barium) is ground finely with coal or coke and roasted in a reverberatory hearth, muffle furnace, Bruckner roaster or rotary kiln. The finer the grinding the better the results obtained.

Air must be excluded so far as possible in the roasting, as the presence of an excess of air tends to form barium carbonate, which in most plants is a waste. This roasting reduces the barium sulphate to barium sulphide, and the resultant roast, known as black ash, is leached in water, yielding a barium sulphide solution, which is filtered and is then ready for use.

The purified zinc sulphate solution and the barium sulphide solution are brought together and raw lithopone is precipitated, consisting of about 30 per cent. zinc sulphide and 70 per cent. barium sulphate.

This raw lithopone is then washed to remove any impurities in the way of soluble salts, which would be injurious to the finished product and which will probably be present owing to the chemicals used in purifying the zinc sulphate, then filtered and dried.

In the drying care must be exercised not to raise the temperature too high, as this would be injurious to the raw pigment.

After thorough drying the raw pigment is calcined in muffles, care being exercised to exclude air so far as possible in this process, as the hot zinc sulphide readily oxidizes at the temperatures required, and it is desirable to keep the zinc oxide content of lithopone as low as possible.

The calcination is done at temperatures ranging from 1,000-1,400° F., according to the practice in various plants. This calcination drives off the water of hydration from the zinc sulphide, and adds to the value of the pigment. Raw uncalcined lithopone has little or no value as a pigment, having little covering capacity, poor tinting strength, and being very difficult to grind in oil, owing to the combined water in the zinc sulphide. The calcination produces certain physical as well as chemical changes in the pigment, and proper calcination is one of the most important steps in the entire process of manufacture. Assuming that the solutions have been properly purified, the calcination determines the grade and value of the finished product.

The hot calcined pigment is discharged from the

calcination furnaces directly into water and quenched. This prevents oxidation of the hot zinc sulphide and, apparently, has a further effect on the properties of the finished product, for which, so far, no satisfactory explanation has been given. Many theories have been advanced as to the actual effect of this quenching, aside from protecting the zinc sulphide from oxidation, but to the writer all seem rather vague and theoretical.

From this point on the process is varied according to practice in different plants.

In some parts the quenched product is wet-ground, washed, filtered, dried and reground, and then packed in barrels or bags for shipment. In others, it is simply ground wet, water-floated, dried and reground and packed. In still other cases the quenched product is dried at once, ground dry and air-floated, and then packed for shipment. The final product should be fine enough that 98-99 per cent. will pass a 300-mesh screen.

The variations in these later steps are probably caused more by the preliminary operations, and the actual conditions of the product itself at the point of quenching, than by any great variation in ideas as to how it should be done to obtain the best results.

The process is not a simple or easy one to operate, for, while none of the steps are difficult in themselves, lithopone is very easily affected by small percentages of impurities or by comparatively slight differences in treatment in the various stages of manufacture, and a technically correct, white, light-proof finished product is by no means easily obtained.

The manufacturers, however, are improving the process all the time, and great improvement has been made in recent years in the general quality and uniformity of the finished product. What was considered a high-grade product five years ago would probably be unsalable today.

Growth of the Industry

The growth of the industry has been remarkable. The U. S. Geological Survey reports lithopone as being manufactured in a small way in 1900 to 1905, but the first actual figures of production given are for 1906, when 4,300 tons was produced. The growth from that time is given as follows:

1906,—	4,300 Tons	1915,—	48,537 Tons
1910,—	14,528 "	1919,—	73,238 "

In thirteen years the increased consumption has been 1,600 per cent. and it has more than doubled every five years. Private sources of information would indicate that the actual production and consumption was much larger than the above, probably fully 100,000 tons in 1920.

During this period, while there has been an increased consumption of zinc oxide and white lead it has in no way compared with the increase in lithopone. The production of zinc oxide in 1906 is given as 74,680 tons and in 1919 as 117,639 tons, an increase of 60 per cent. against 1,600 per cent. for lithopone.

The price of lithopone from 1910 to 1915 was fairly constant at about 3½¢ to 3¾¢ per pound. During the war the price increased rapidly and reached the peak in 1916 at 14½¢ to 15½¢ per pound. It then dropped to 6¢ to 6½¢ per pound in 1917. From 1917 to 1921 the price has fluctuated at from 6½¢ to 8¢ per pound, the market today being 7¢ to 7½¢.

During 1919, the average cost of production in the United States was given by the Tariff Commission as \$120.40 per ton, or for the 73,238 tons a total cost of \$8,817,855.20, and of this amount 20.5 per cent.,

or \$1,804,360.31, was the actual cost of the zinc used.

The importations of lithopone have never amounted to more than 16 per cent. of the consumption in the United States, and from 1910 to 1920 have averaged 10 per cent.

Lithopone, as marketed, contains actually 20 per cent. of metallic zinc. The method of manufacture necessitates the use of nearly 25 per cent. of metallic zinc by weight of the finished product, and, based on the Government report for 1919, this would indicate

a consumption of about 18,400 tons of metallic zinc in lithopone.

While this is not large, compared with the total consumption of zinc for the same year, the increase from 1,070 tons of metallic zinc used in 1906 to 3,642 tons in 1910, and from 12,144 tons in 1915 to 18,400 tons in 1919, of metallic zinc used in the manufacture of lithopone is significant as indicating the increasing importance of the lithopone industry to the producer of zinc.

Amended Standards for Cocoa Products

Revision of the definitions and standards for cocoa products is announced tentatively by the Joint Committee representing the Association of American Dairy, Food and Drug Officials, the Association of Official Agricultural Chemists, and the United States Department of Agriculture, which invites suggestions and criticism regarding the tentative revised standards. The text of the proposed definitions and standards is as follows:

Cacao Beans, Cocoa Beans, are the seeds of the cacao (*Theobroma cacao* L.).

Cacao Nibs, Cocoa Nibs, Cracked Cocoa, is the roasted, broken cocoa bean freed as far as is practicable from cacao shell or husk.

Chocolate, Plain Chocolate, Bitter Chocolate, Chocolate Liquor, Chocolate Paste, Bitter Chocolate Coating, is the solid or plastic mass obtained by grinding cacao nibs without the removal of fat or other constituents except the germ, and contains not less than fifty per cent. (50%) cocoa fat and, on the moisture and fat-free basis, not more than eight and five-tenths per cent. (8.5%) total ash, not more than four-tenths per cent. (0.4%) ash insoluble in hydrochloric acid, not more than five and six-tenths per cent. (5.6%) ash insoluble in water, not more than seven per cent. (7%) crude fiber, nor more than four per cent. (4%) cocoa shell.

Sweet Chocolate, Sweet Chocolate Coating, is chocolate mixed with sugar (sucrose), with or without the addition of cocoa butter, spices, or other flavoring materials, and contains, on the moisture, sugar and fat-free basis, no higher percentage of total ash, ash insoluble in hydrochloric acid, ash insoluble in water, crude fiber, or cocoa shell, respectively, than is found in chocolate.

Cocoa, Powdered Cocoa, is chocolate deprived of a portion of its fat and finely pulverized, and contains not less than twenty per cent. (20%) cocoa fat and, on the moisture and fat-free basis, no higher percentage of total ash, ash insoluble in hydrochloric acid, ash insoluble in water, crude fiber, or cocoa shell, respectively, than is found in chocolate.

Sweet Cocoa, Sweetened Cocoa, is cocoa mixed with sugar (sucrose), and contains not more than sixty per cent. (60%) sugar in the finished product, and, on the moisture, sugar and fat-free basis, no higher percentage of total ash, ash insoluble in hydrochloric acid, ash insoluble in water, crude fiber, or cocoa shell, respectively, than is found in chocolate.

Milk Chocolate, Milk Cocoa, Sweet Milk Chocolate, or Sweet Milk Cocoa, respectively, is chocolate, cocoa, sweet chocolate, or sweet cocoa, which contains not less than twelve per cent. (12%) of whole milk solids in the finished product.

The committee is considering the need for fixing a minimum limit for chocolate product in milk chocolate, etc., and will be glad to receive suggestions regarding this point from the trade and other interested parties as well as any other suggestions or criticism pertaining to the proposed revision. Communications should be ad-

ressed to the secretary of the Joint Committee on Definitions and Standards, Bureau of Chemistry, Washington, D. C., and mailed in time to reach him on or before September 15, 1921.

National Exposition of Chemical Industries

The location of the Seventh National Exposition of the Chemical Industries, Sept. 12-17, at the Coast Artillery Armory in the Bronx, has been advanced by some as militating against the general patronage of exhibitors and the high attendance that have made prior exhibitions notable.

This surmise fails of substantiation in the growing list of exhibitors, which will surpass prior efforts of the management. The superior accommodations provided exhibitors in unobstructed floor space on one vast level contribute to an equality of interest impossible with the separation of exhibits on several floors as obtained in prior exhibitions at the Grand Central Palace.

The accessibility of the Armory by every means of transit in New York City, the many conveniences provided for visitors and the high character of the supplemental educational attractions in the form of addresses by experts in the chemical and allied industries, and of motion pictures of manufacturing processes, to say nothing of the exhibits themselves, assure an attendance both in volume and in sales possibilities that will make the Seventh Exposition as successful as was in turn each of its predecessors.

Because of the competition of cheap German aluminum ware, it is announced that the Aluminum Line of steamships operated by the American Bauxite Co. in the trade bringing bauxite from Dutch and British Guiana to New Orleans, will be closed November 1.

* * *

The Rasin-Monumental Co., National Marine Bank Building, Baltimore, Md., has plans under way for a new fertilizer plant in Baltimore, estimated to cost close to \$1,000,000 with machinery. The company is now operating a plant in the Curtis Bay district.

* * *

Ellis C. Soper, chemical engineer, has organized and is president of the Midwest Chemical Co., Nashville, Tenn., which will erect a plant for the reduction of phosphate rock for direct application as a fertilizer, at Thompson Station, Tenn., on the Louisville & Nashville R. R., where the company owns and controls about 700 acres of deposit.

* * *

Adrian D. Joyce, president of Glidden Co., Cleveland, Ohio, announces the alliance through a stock interest and arrangement of his company with Naamloze Vennootschap, Amsterdam, Holland, whereby the former delegates to the Dutch organization the manufacture of certain Glidden specialties in exchange for the exclusive manufacture and sale in America of "Ripolin," an enamel developed by Riep, the Dutch paint chemist.

Personal Items

E. A. Dieterle, formerly assistant chief chemist, Koppers Co., Pittsburgh, Pa., is now chief chemist of the Chicago By-Products Coke Co.

* * *

W. H. Ransom, formerly major, Ordnance Dept., U. S. Army is now with The Celluloid Co., Newark, N. J.

* * *

J. H. McGachan, formerly chief chemist, Mason Tire & Rubber Co., Kent, Ohio, is now with the Rex-Hide Rubber Mfg. Co., East Brady, Pa.

* * *

E. M. Bailey, New Haven, Conn., has been appointed Connecticut state chemist for a 2-year term beginning August 4th.

* * *

James L. McClellan has resigned his position with the Amlac Company, Boston, Mass., and is now associated with the National Fiber & Insulation Company, of Yorklyn, Del., as chief chemist.

* * *

Ernest F. Kling, formerly chief chemist, Morgan & Wright Co., Detroit, Mich., and for the past year with the Batavia Rubber Co., Batavia, N. Y., has been appointed factory manager.

* * *

E. Richardson, formerly of the glass technology department, National Lamp Works, Nela Park, Cleveland, Ohio, is now chief chemist, Libbey Glass Mfg. Co., Toledo, Ohio.

* * *

F. H. Pendleton, formerly chemist, Gortonpew Fisheries Co., Gloucester, Mass., is a member of the staff of Skinner, Sherman & Esselen, Inc., 248 Boylston St., Boston, Mass.

* * *

Carleton B. Edwards, formerly research chemist with E. I. du Pont de Nemours & Co., is now with the Republic Creosoting Co., Indianapolis, Ind., in the same capacity.

* * *

Charles A. Drake, formerly in charge of the general varnish department of the Chicago Varnish Co., is now in charge of manufacture for the Unkefer Varnish Co. of Chicago.

* * *

Sloan S. Sherrill, formerly mechanical engineer for the Chemical Construction Company, is now employed in the same capacity by the Calumet Baking Powder Company, Joliet, Ill.

* * *

Maj. Gen. W. L. Siebert, head of the Chemical Warfare Service during the war, finds in his retirement on his 285-acre farm on Barren River in Warren Co., Kentucky, occupation and profit in the exploitation of oil discovered on his land.

* * *

W. L. Keen, chief engineer of the Semet-Solvay Co., has resigned and will be succeeded by A. T. Leavitt, who has been assistant manager of engineering. William Hutton Blauvelt, manager of the plant development department, has been made consulting engineer.

* * *

G. J. Fink, formerly of the Hooker Electro-chemical Co., and a graduate of Cornell University, has been added to the technical staff of the chemical department

of the National Lime Association, where he will be engaged on research problems.

* * *

Hugh B. Lee, recently general superintendent of the Mutual Chemical Co. of Canada at Black Lake, Quebec, is now general manager of the Phosphate Mining Co., Nichols, Fla.

*

Harry F. Lewis, A.B., A.M. (Wesleyan), Ph.D. (Illinois), at present with the National Aniline and Chemical Company, Buffalo, N. Y., has been elected associate professor of chemistry at Cornell College, Mount Vernon, Iowa.

* * *

Dr. I. Newton Kugelmass, director, department of chemistry, Howard College, Birmingham, Ala., will leave in September for Belgium where he will engage in research work in colloid chemistry at the University of Brussels during 1921-1922.

* * *

Anastasius Parobek, city chemist of Trenton, N. J., recently celebrated his 25th anniversary in the chemical industry. Prior to his establishment of the Parobek Chemical Laboratory he was associated with the J. L. Mott Co. in Trenton.

* * *

Glen D. Bagley and Alexander L. Field, until recently with the Electro Metallurgical Co., Niagara Falls, N. Y., have become associated with the Union Carbide and Carbon Research Laboratories, Inc., Long Island City, N. Y.

* * *

Dr. Albert S. Burdick, for 17 years associated with the Abbott Laboratories, Chicago, Ill., has been elected to the presidency to succeed Dr. W. C. Abbott, deceased. Dr. Burdick is a graduate of Alfred University, Alfred, N. Y., and Rush Medical College, Chicago.

* * *

E. S. Crosby, formerly sales manager of the U. S. & Cuban Allied Works Engineering Corp., has been appointed Eastern district sales manager of the Celite Products Co., 11 Broadway, New York. Previous to Mr. Crosby's foreign service in the army he was assistant sales manager of the De Laval Steam Turbine Co., of Trenton, N. J.

* * *

Dr. Irving Langmuir, assistant director of the Research Laboratory of the General Electric Company, sailed for Europe Aug. 13 to attend the annual meeting of British Association for the Advancement of Science to be held in Edinburgh, Scotland, Sept. 7-14. He also will attend a meeting of the Faraday Society in London on Sept. 28 and will be awarded the honorary degree of Doctor of Laws by the University of Edinburgh on Sept. 13.

* * *

Robert A. Millikan, professor of physics at the University of Chicago, has been appointed director of the Norman Bridge Laboratory of Physics at the California Institute of Technology and chairman of the executive council of the institute. Dr. Millikan has for a number of years spent the winter term at the institute, but he will now give his whole time to it, beginning in October, when the new physical laboratory will be ready for occupancy.

Industrial Notes

The Hercules Powder Co., Wilmington, Del., will enlarge and improve its commercial powder plant and resume production in the fall at Rayville, Ill.

* * *

Textile Alliance, Inc., 45 E. 17th St., New York, has acquired a factory structure in Long Island City which it will use for the handling of dyes.

* * *

The Dominion Oxygen Co., Ltd., Toronto, Canada, will erect a plant in Montreal to cost \$250,000, which will duplicate its Toronto works and double the production capacity.

* * *

The Schaffer Engineering & Equipment Co., Pittsburgh, Pa., has combined its sales and manufacturing offices at its factory at 2828 Smallman St., in that city, where a new office structure has been built.

* * *

The Atlantic Refining Co., Philadelphia, Pa., is reported to have acquired the Naull shipyard, on the Cape Fear River, near Wilmington, N. C., and has plans under way for the erection of an oil refinery.

* * *

The Canton Oxygen Co., capital stock \$250,000. Canton, Ohio, will shortly begin the erection of a plant for the manufacture of oxygen, involving an expenditure of \$50,000 or more for building and equipment.

* * *

The Silica Gel Corporation, a subsidiary of the Davison Chemical Co., Baltimore, Md., has been organized to exploit commercially the industrial applications of silica gel, the latter corporation owning 50 per cent. of the 600,000 shares of no par value of the subsidiary.

* * *

The Wamesit Chemical Co., Lowell, Mass., capital \$100,000 in preferred stock and 3,000 shares of no par value, has been organized to take over the business and property of the Avery Chemical Co. The officers are: George Stevens, president; J. H. Murphy, treasurer, and C. F. Hobson, general manager.

* * *

The American Chemical & Sugar Machinery Co., Colonial Trust Building, Philadelphia, has acquired the plant of the Harrison Chemical Co., fronting on the Delaware River, Chester, Pa. The new owner will remodel the buildings, and plans for the installation of equipment at an early date.

* * *

The Electro-Pure Products Co., 39 Cortlandt street, New York, has been organized to engage in the manufacture of hydrogen peroxide, a superior grade of which is claimed to be possible by the Edelman automatic control and equipment. Plans are under way for a plant of 10 tons daily capacity. P. E. Edelman is general manager and P. H. Bascom is chemical engineer of the company.

* * *

F. A. Sieberling, Akron, Ohio, who was released from administrative responsibilities in the recent financial reorganization of the Goodyear Tire & Rubber Co., and associates have acquired the plant and business of the New Castle Rubber Co., New Castle, Pa. The name of the company will be changed to the Lehigh Tire & Rubber Co. A number of improvements will be made and the plant placed in service at an early date.

The American Tar Products Co., Chicago, Ill., will begin the construction on a 39-acre tract adjoining the drainage canal of a plant to utilize the tar of the By-Products Coke Co., with whose plant it will be connected by pipe-line. Plant construction will embrace 10 one and two story buildings and numerous storage tanks, devoted to the production of tar distillates.

* * *

The California Master Products Co., Los Angeles, Calif., L. F. Caswell, president, has acquired a 500-acre tract in the Mojave Desert containing a deposit of clay possessing colloidal characteristics similar to the English material used as an accelerator by English rubber manufacturers and recommended as a soap ingredient, and has set up a plant for the production of the clay.

* * *

The Carnegie Steel Co. has acquired 1,000 acres in the Youngstown-New Castle district and will erect a by-product coking plant, to cost ultimately \$25,000,000, which will be connected by a spur of the Bessemer & Lake Erie R. R. with coal fields in Armstrong Co., Pa. Plant construction has begun and railroad right of way procured.

* * *

H. C. Neren, superintendent of the Viscose Co.'s artificial silk mill at Roanoke, Va., a view of which appears on page 299, states that approximately \$1,000,000 will be expended for the enlargements and improvements. The plans now under consideration provide for two additional sections which will duplicate the present plant. About 1,500 more operatives will be required. The new structures will be of brick and cement and include an office building.

* * *

The Maryland Vegetable Oil Co., Baltimore, Md., has been organized with a capital of \$1,250,000 8 per cent. preferred, par value \$100, and 10,000 shares of common stock, without par value, to take over the business of the Coconut Products Corporation, the mortgage on whose property was foreclosed, following default in the payment of the interest on the bonds. The assets of the latter corporation, including plant and equipment, represent a reported consideration of \$790,000.

* * *

The Research Corporation, 25 W. 43d Street, New York, under agreement of July 1, has undertaken the commercial development of the automatic control system and devices of Philip E. Edelman, E. E., 39 Cortlandt Street, New York, applicable to chemical manufacturing processes. Aside from extending their application, the Research Corporation will be the exclusive licensees in certain industries without disturbance of the work under licenses already established, thus permitting the more intensive application in production control of Mr. Edelman's inventions.

POSITION WANTED

DEVELOPMENT and invention in the fields of petroleum and asphalt refining, thermoplastics, resin and pitch products, gasoline production; as well as supervision of manufacturing processes. Graduate chemist (M. I. T.) desires connection with progressive company interested in the above and allied fields. Capable of acting as patent solicitor and manager or assistant manager of development work. Salary dependent on responsibility. Address: M. M., care of CHEMICAL AGE.

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Economic Importance of Waste Products Utilization

By Walter H. Dickerson, M.E.

President, Industrial Waste Products Corporation

WE have been called the most profligate of nations, and well we have deserved that stigma. We have drawn on our natural resources in a manner that is appalling and with very little thought to their ultimate limitations. It is only within a comparatively recent period that some of our industries have been made to realize that our natural resources of raw materials are limited.

Today, most of us have acquired at least a slight appreciation of the fact that there is a final limitation to natural resources and some effort is being made toward their proper conservation. But even now in the light of past history and experience, collectively and individually, we are criminally negligent with regard to our national waste problems.

Waste Classified

In its broadest sense, waste may be divided into three classes: First, that which comes from squandering our natural resources; second, that which is due to loss occasioned by unemployment due to labor strikes and lockouts, irregular operations of industry, capital tied up in idle equipment and similar causes, and third, that which exists in the refuse from every municipality and every industrial operation.

The first is largely a matter of education of the public to the point where they will in self-protection, force legislation for the conservation of natural resources. It is impossible to arrive at even an idea of what this class of waste means in dollars and cents to the country.

The second depends largely upon a more efficient handling of our industrial operations and a better understanding between capital and labor. What this form of wastage amounts to, may be appreciated from the following figures: A careful estimate shows that as a result of strikes during the year 1919, labor lost approximately \$750,000,000 and American industries nearly one and a quarter billion dollars, and our Congress is struggling to reduce the running expenses of the government a few million of dollars.

A comprehensive program has been laid out by the American Engineering Council of the Federated American Engineering societies to prevent the wastage of labor, capital and materials, by the better stabilization of industry and a better condition in our industrial relations.

The third class of waste is our national refuse pile, and it is to this phase of our waste problem that I want particularly to draw your attention, as it is the most immediately approachable and touches the chemist and engineer and those in charge of our manufacturing and sanitation activities.

The countries of Europe, and especially Germany, are making rapid readjustment from a war footing to peace conditions, and are already putting into effect a co-ordinated industrial effort which was thought to have been impossible for a long time to come.

How is this world competition going to be met? That is the vital question which is before our industries today. Is not one of the first logical moves, the salvaging of the recoverable products which exist in the refuse



WALTER H. DICKERSON, M.E.
President, Industrial Waste Products
Corporation

waste materials and waste waters from practically every industrial operation and from municipal and domestic sources as well? This part of our national waste problem does not require an elaborate study of the relations between capital and labor and of the intricate conditions surrounding that question, as in nearly every instance it is definite and tangible, and susceptible of being attacked without any other consideration.

Industrial Waste

The phase of our waste problems, however, which I want especially to emphasize is that identified with our industrial and manufacturing operations. As chemists and engineers this class of waste is one in which we should be most vitally interested. Furthermore, the successful salvaging of our trade wastes and the recovery of by-products may mean the difference between profit and loss when it is necessary to meet European competition. The loss that is taking place in the great bulk of our industries is almost unbelievable. It reaches from the smallest to the greatest operation. The influence which the complete utilization of this waste and refuse would have upon our industrial economy can hardly be computed. Let us take a few concrete examples.

Fruit-Preserving Waste

Previous to the war there was produced from the deciduous fruit packing industry in California over twenty thousand tons of peach pits annually. These were purchased each year by certain German interests and shipped to Germany. Upon reaching Germany, these pits were cracked and the kernels removed and submitted to various treatments which yielded hydrocyanic acid and a number of oils suitable for the manufacture of liqueurs and essences. The residue of these kernels after extraction furnished a valuable cattle food for either domestic consumption in Germany, or to be sold in foreign markets. The nut shells were converted into carbon, which had a high chemical value for chemical and industrial purposes.

It will be recalled that the charcoal made from these shells was the most valuable form of charcoal for gas masks for the protection of our soldiers against the poison gas used against them by the German army. The oils were sold back to this country at a nice profit. To-day it is gratifying to know that this problem is being worked out in this country.

A Caustic Soda Waste

Some months ago the writer made a survey of one of the plants of a well-known corporation and could hardly believe the facts developed. There were being thrown away in the sewage every day of normal operation over twenty thousand pounds of caustic soda. This had been going on for several years, with a net loss of anywhere from \$150,000.00 to \$200,000.00 per year, depending upon the ruling market price of soda. Now \$150,000.00 per year is 6 per cent on \$2,500,000.00, and this is only one of several plants in the same line of industry. Not one of these plants is recovering its waste caustic liquor.

Wool Scouring Waste

In the woolen industry there are scoured about 600,000,000 lbs. of wool annually. All wool contains varying percentages of greases, potash and soluble nitrogen, depending in what part of the country the sheep have been raised. Some will show as high as 40 percent grease, 9 percent to 10 percent of potash as K_2O , and $\frac{1}{2}$ percent of soluble nitrogen. A fair average figure would be 15 percent of grease, 3 percent potash and $\frac{1}{2}$ percent nitrogen. There is then from the waste

wool scouring liquors, a possible annual recovery of 90,000,000 lbs. of grease, 18,000,000 lbs. of potash, and 3,000,000 lbs. of water soluble nitrogen. During the war the high price of lanolin induced a number of the woolen mills to install centrifugal separators for the extraction of lanolin. Two of the large mills also installed recovery plants, not only to recover lanolin but potash as well. But even where the liquors are put through the centrifugal machines to extract the lanolin, the liquors discharged from this operation still contain all the combined fatty acids, potash and nitrogen and are as great a menace to stream pollution, as if they had not been processed at all.

Fisheries Waste

Upon the Atlantic Coast, from Canada to Texas, there are about fifty plants manufacturing fish oil, employing the familiar process of cooking the fish by steam and then pressing. The mixture of water and oil is sent to settling tanks, the oil rapidly separating, when it is pumped to the storage and the watery portion being run to waste in the adjacent body of water. These waste waters contain an average of better than ten percent solids, which show an analysis of 12.85 percent nitrogen, 4.28 percent total phosphoric acid, 6.85 percent potash, 15.7 percent equivalent to ammonia, and .66 percent equivalent to bone-phosphate of lime, and also .25 percent of grease. A careful survey indicates that there is contained in an average discharge of waste waters from each plant, recoverable solids to the extent of 500 tons to 1,000 tons annually, depending upon the length of the season. Even under depressed values ruling at the present time, these solids are worth from \$75.00 to \$85.00 per ton for poultry food, showing a total possible value to be recovered from this small class of waste of upward of \$2,000,000 per annum. And this does not take into consideration the large number of fish canning plants upon both the Atlantic and Pacific Coasts, which have a very large amount of refuse which in nearly every case is treated as a total waste today.

Waste of the Sugar Industry

I might continue through a whole gamut of various industries, giving statistical figures on values represented in the wastes and refuse passing out daily from such industries. There are a few others of a different class, however, which I wish to mention. In those industries having to do with the production of our daily necessities, it would seem reasonable that every possible effort should be made to utilize to their fullest extent every by-product which could contribute in any way to reduce the cost of production or manufacture of such necessities. And it is not unreasonable to feel that those financially responsible for the conduct of such industries should lend every energy to an effort in this direction, especially if any economy could be accomplished at a profit. In some cases this has been done to a greater or less extent, but much remains to be accomplished in this particular field.

Sugar is one of our most vital daily necessities. Yet how many are aware of the waste involved in its production? In the manufacture of raw sugar from the cane, there is a by-product of approximately five gallons of molasses for every ton of cane ground. At many of the centrales the disposal of this waste molasses is a very serious problem. While it is quite true that there are very large quantities of molasses used in this country for various purposes, such as for the

production of alcohol, cattle feed, and other purposes, as well as the refined product for human consumption, there are still enormous quantities run to waste. In Cuba only about 25 percent of the average crop of molasses is put to any use, the remainder being entirely wasted and frequently it is an expense to get rid of it.

The most feasible use for this waste molasses is naturally the production of industrial alcohol. As commercial conditions return to normal there will be an increasing demand for this product. It is destined to play a very important role as motor fuel, especially in view of the increasing price of gasoline. There is to-day being used in Cuba a mixture of alcohol and ether as motor fuel with very satisfactory results, and its practical value has been proven beyond any question. During the past year this motor fuel, which will give 20 percent greater mileage per gallon than gasoline, has been selling at an average of 40c. to 50c. per gallon. With the price there of gasoline ruling at 50c. per gallon and better, there has been no difficulty in disposing of all that was produced and the market would absorb much more, to say nothing of export markets of the European continent.

In the manufacture of alcohol there is also produced approximately one percent of fusel oil, for which there is always a demand. The spent distillery slops are rich in nitrogen and potash and can be recovered and returned as fertilizer to the land from which the cane has been harvested.

Taking the 1920 crop in Cuba; if the waste molasses from that had been utilized for the production of alcohol, motor spirit, fusel oil and fertilizer, the ruling price would show at least \$15,000,000.00 net returns to the Cuban sugar production. What is true of Cuba, is also true of every other sugar producing district in the world. The salvaging of possible values from molasses which is now being wasted could be a very substantial contribution to the cost of the sugar to the public.

Waste of the Packing Industry

While it is quite true that the packing industry has reached a high degree of perfection in the utilization of many of its by-products, it still has a very serious waste problem before it. Very few plants have solved the question of satisfactorily handling their sewage.

I recently surveyed one of the larger of the packing plants and found that under normal operating conditions, the sewage disposed from this plant daily, contained on an average of fifty tons of solid matter, which is all discharged into "Bubbling Creek."

There has been considerable investigation by the packers on the handling of their sewage, and very comprehensive tests with the activated sludge process have demonstrated that the packing house sewage can be handled by this process and produce an effluent perfectly satisfactory from a sanitation standpoint to be discharged into any drainage system. What to do with the sludge containing the solids was the important remaining question. The ordinary methods of procedure did not lend themselves to the handling of this material and so there the matter rested. In the particular plant referred to, the investigation disclosed that there was enough waste heat escaping from their power plant to reduce this sludge to a dry powder ideally suited for fertilizer purposes. This process of procedure naturally requires special methods for handling the material. These dried solids have, at the lowest

estimates, a value as fertilizer of \$20.00 per ton. Thus in this particular case there is being thrown away daily, material to the value of \$1,000.00 or after deducting operating and interest charges, a net yearly return of not less than \$225,000.00. This sum would pay the interest charges on \$3,250,000.00.

Those figures are just for one particular plant and what is true in this case is true in nearly every packing plant on a greater or less scale, depending on the size of operation. The aggregate would be a very substantial reduction in the cost of our daily food.

It should be apparent from these figures that even in those industries of long experience and highly developed processes of manufacturing, that there are very vital waste problems to be solved.

Waste of the Pulp Industry

We are all doubtless more or less familiar with the various processes of making paper pulp, notably the sulfite, sulfate and soda processes. In the cooking of the wood in the digesters by any of these processes, approximately fifty percent of the dry weight of the wood is dissolved into solution, leaving the cellular fibre for conversion into paper. These waste liquors constitute our greatest industrial waste to-day. For every ton of pulp produced, there is practically an equal weight of solid matter extracted from the wood and carried away in the waste liquors.

Taking the sulfite pulp industry alone, there was produced in the year 1920, over 1,576,000 tons of this class of chemical pulp. There is required approximately two cords of wood for every ton of pulp produced, which would mean that there were 3,000,000 cords of pulp wood used in this branch of the industry alone. At the prevailing price for pulp wood, this raw material cost the pulp manufacturer over \$50,000,000.00 per year laid down in his yard. The tanners years ago cut the hemlock trees simply for the bark, letting the timber itself rot in the forest. To-day the pulp manufacturer harvests pulp wood, takes the cellulose fibre out of it and throws the lignin or non-cellulose substance away.

If these waste liquors could be used completely, so as to return the proportionate share which they represent of the original cost of the wood, there would be saved to this branch of the industry annually over \$25,000,000.00. This sum of money would pay the interest on over \$400,000,000.00 capital.

There are a few of the pulp mills at the present time recovering their sulfite liquors, but this constitutes only about 5 percent of the total. Those pulp manufacturers who have made an effort to utilize this great waste are deserving of the greatest credit for the work they have done in blazing a pioneer trail which it is believed eventually will lead to the establishment of a branch of the pulp industry which will ultimately be of as vital importance to the manufacturer as the production of the pulp itself.

Practically all the work that has been done upon this subject of the waste stream pollution by the paper manufacturer, has been the result of individual effort. There has never been a properly co-ordinated effort toward a solution of this problem. With a result or goal of such magnitude to be accomplished, are not the pulp manufacturers warranted in spending a very substantial sum annually toward this work? Many uses for this material have been indicated, which if successfully developed would consume a very large percentage of these waste liquors. But much work and research are necessary to produce the desired products

in a commercially satisfactory manner. This is the work that the pulp manufacturers should be only too willing to undertake. Very large sums of money and much effort have been expended in improving various phases of the pulp making processes and the conversion of the pulp into a sheet of paper. Yet at the same time, the manufacturers have sat complacently by and allowed half of their original material (and the richer half from a chemical standpoint) to go down the sewer. Perhaps if the chemical pulp manufacturers adopted a different system of bookkeeping and charged up half of their wood account to profit and loss, they might get a different viewpoint of this subject.

Competition and Waste Utilization

This country has been blessed with an abundance of natural resources and raw materials as no other modern community has ever enjoyed. As long as the raw materials were abundant and cheap enough, the disposition on the part of the manufacturer has been to ignore this question of waste.

If we look back upon the development of any particular industry, we invariably find that primarily it was started to produce one main or principal product and no attention was paid to the possibilities that lay dormant in the by-products. Eventually, as the influence of changed conditions were felt, many industries have utilized more or less of their by-products. But in how many cases has competition forced this?

Too frequently so long as the volume of business of the principal product being manufactured and the margin of profits were satisfactory to the management, little consideration was given to any other question. If the cost of raw materials went up, it was added to the finished product irrespective of what losses might be going into the refuse heap and into the sewer.

On the other hand, in many instances, those in executive authority in an organization may not be in a position nor have the training to appreciate the losses that are being occasioned through the refuse that is discharged from their plants. In such cases it too often happens that those in charge of individual plants are not willing to take the responsibility of any attempts at salvaging their wastes or do not want to be bothered with the additional work involved.

The working out of a waste recovery problem is frequently turned over to the operating staff of the plant, which is often unwise, for those in charge of operations usually have their hands full getting out product and their experience is along routine lines. They cannot be expected to have the knowledge and experience necessary to salvage their plant waste which only experience in this field of work can give. It is not surprising, therefore, if they are not able to give satisfactory results.

In many cases where manufacturers have been confronted with a serious problem in connection with their industrial wastes, they have attempted its solution without first acquiring a clear understanding of the scientific principles involved in the processes available for the treatment of these wastes. This treatment is a subject entirely different from that which the manufacturers have to deal with in their business and in which they are primarily interested. The salvaging of their wastes and the most efficient method of handling them is only of secondary interest and importance from their point of view.

The fact cannot be too strongly emphasized that the problems involved in the handling of wastes and especially the salvaging of values from industrial wastes,

requires special treatment and experience. Whatever our disposition toward this question of the utilization of wastes may have been in the past, the time is not far distant when not only our industrial organizations and civic communities but every individual will be forced to give this subject much close attention.

Many of our raw materials are steadily increasing in cost, the sources of some of them in this country are already within defined limits, and the item of labor is relatively an increasing factor in our production costs. As our communities increase in population and our manufacturing enterprises multiply, the question of sanitation and stream pollution will be of increasing importance and will force legislation to prevent such pollution and abuse. The communities adjacent to our large coast cities will not much longer tolerate their beaches being littered with city refuse and garbage dumped just a few miles out into the ocean.

Economic Significance of Waste

Is it not a matter of foresight and prudence for manufacturers to take their waste problems in hand and work out a scientific utilization of these wastes, thereby establishing an additional source of income, rather than to wait until they are suddenly forced by law to take care of them by some disposal system at a heavy expense?

It is not alone the duty of every industrial organization but of every individual as well to take an interest in and give aid to this matter for in just the degree that we have mastered it will our industrial position be influenced.

Under the stress of patriotic appeal during the war, we as a nation showed only too clearly the millions that could be saved annually through the salvaging of our wastes. It is to be regretted that some form of equally effective stimulus could not be kept before the people continuously. This nation should be made to realize that waste is wealth thrown away. Every dollar of value that is salvaged from waste is just that amount of found capital and just that amount added to the nation's wealth, while every dollar that is thrown away of recoverable values existing in waste or refuse of any description is just that much capital lost to us for all time. That which is contained in these wastes and refuse represents just so much raw material and so much labor. If we salvage this, we have created just that much capital for future use, which becomes available as a purchasing or investment power.

It should be apparent what effect this would have, one way or another, on our position in world affairs industrially. Protective tariffs and embargo may lessen the severity of foreign competition within our own borders but those measures will not help us in competition in the outside markets. It is the price at which we can afford to sell our commodities to the world which will determine our position in international commerce and our internal success.

Can there be any doubt or question of the profound influence that this, our national waste problem, has upon our economic position and that eventually it may be the turning point in our ability as a nation to develop and compete in the world's commerce?

The successful solution of this problem is in the hands of the chemists and engineers, but without the cooperation of those in executive and financial control, little can be accomplished. Upon the latter devolves the duty to give the heartiest support and encouragement to the chemists and engineers in their efforts to solve this, one of our most economically vital problems.

Cellulose Ethers and Esters

Combinations of Acid Radicles and Alcohol Groups with Cellulose Derivatives. The Organic Esters of Cellulose and Starch. Unflammable Celluloid. Acetate Silk. The Past, Present and Possible Future of These Competitors of Pyroxylin, Nitrocellulose and Collodion.

By Clarence E. Lehmann

Of the Laboratory of Edward C. Worden

THE organic esters and ethers of cellulose, in contradistinction to the better known and more widely investigated nitric esters typified by gun cotton, pyroxylin and collodion, lay claim to industrial recognition from the fact that they are relatively of diminished flammability, burning with no greater speed than the initial cellulosic material from which they are prepared, and also to the fact that they are soluble in a large number of inexpensive and readily obtainable fluids, and hence are of wide application in the peaceful arts.

Early Investigations of the Cellulose Esters

In 1865 Paul Schuetzenberger disclosed to the French Academy of Sciences that when cellulose as cotton or filter paper is heated under pressure with acetic acid and acetic anhydride, solution of the cellulose takes place after a time with the result that a viscous gummy liquid results, insoluble in water but readily soluble in acetic acid.

No technical applications of this discovery were suggested. Subsequent investigators, as Girard, Liebermann and Hoermann and Erwigs and Koenigs, apparently confined themselves to an investigation of the subject from a purely academic point of view. From a perusal of the contributions of these scientists, one would not suspect that the subject possessed any technical interest or might lead to results of commercial utility. While each repeated the work of his predecessors and carried the sum total of knowledge a step further, there was no serious attempt to commercialize the results obtained.

First Patented Process by Cross and Bevan

The interest aroused by the accumulation of information upon this subject engaged the attention of an increasing number of men of perseverance and reflection, but it remained for Cross and Bevan to crystallize these ideas in practical form, a patent being granted to them in England in 1894 for the manufacture of cellulose acetate in commercial quantities by the action of zinc acetate and acetyl chloride upon a hydrated form of cellulose, the patentees suggesting possible uses for the material in pharmacy and in surgery as a substitute for the "liquid cuticle" (collodion) used at that time.

The cellulose acetates produced up to this time, however, had little commercial value, not only because they were deficient in tensile strength and flexibility, but also because of the fact that they were soluble only in toxic or relatively expensive solvents such as chloroform or acetylene tetrachloride (tetrachlorethane).

At this point, the development of the art is analogous to the progress of the nitrocellulose industry in its earlier days, when the subject was advanced only at those times when someone discovered new solvents or improved methods in the application of solvents then known. All methods for the acetation of cellulose divulged up to this time depended upon a preliminary treatment (breaking down of the cellulose molecule). This not only involved expense and time in the preparation of the cellulose for the acetation process proper, but also decreased the strength of the final product and thereby lessened its commercial applicability.

Discoveries of Miles

The most important technical advancement after Cross and Bevan is undoubtedly that made by G. Miles, especially the patent taken out by him in the United States in 1905. Five years previous to this, a patent had been granted to Miles for the acetation of cellulose, which marked an important advance in the art, in that he was able to acetate cotton and other forms of cellulose without previous treatment.

In 1905 he described a method for the commercial acetation of cellulose, whereby after the esterification is completed, a partial hydration of the product is brought about by the withdrawal of acetic acid from the formed cellulose ester, by the addition of water or other body, as alcohol, glycol or glycerol which contain one or more hydroxyl groups. The value of this discovery lies in the fact that whereas theretofore it was possible to make solutions of cellulose acetate only in such solvents as chloroform which was both poisonous and expensive, Miles was able, by controlling the process of hydration after acetation, to obtain a series of acetated celluloses readily soluble in acetone and a number of inexpensive solvents, and from which solutions films and filaments of great elasticity and tensile strength could be obtained by simple evaporation of the solvent.

Miles acetated unmodified cellulose as cotton or tissue paper with acetic acid, acetic anhydride and a small amount of catalyst as sulphuric acid. He obtained as the first stage of the process normally acetated cellulose (a tri-derivative based on a C_6 formula for cellulose), soluble in chloroform but insoluble in acetone, which upon progressive hydration by the elimination of water gradually lost the solubility in chloroform while at the same time dissolving more and more completely in acetone. The hydration period was interrupted at the point where the cellulose acetate was found to be completely soluble in anhydrous acetone but only plastic in warm chloroform and insoluble in cold. This point was found to yield an acetate of maximum strength and tenuity for film formation.

Disclosures of the Brothers Dreyfus

It should be mentioned that the acetation of cellulose is sharply distinguished from nitration, in that nitrocellulose is not soluble in the nitrating mixture, whereas acetylcellulose dissolves in the acetating mixture. However, Mork described a process for cellulose acetation whereby the addition to the acetating bath of some fluid not a solvent of cellulose acetate could be made, in which case the cellulose acetated without visible change in structural form in a manner analogous to cotton nitration. However, as there are no uses for cellulose acetate in the dry form, this method, while interesting, has no technical advantages.

The first of the Dreyfus patents was applied for in 1911, since which time this branch of technical literature has been enriched by the appearance of over two hundred patented processes covering nearly every phase of this art and the intermediate materials used in acetate formation. Dreyfus clearly pointed out the inner mechanics of cellulose esterification and their application to the various commercial uses, especially for lacquers,

artificial leather, photographic films and artificial filament formation.

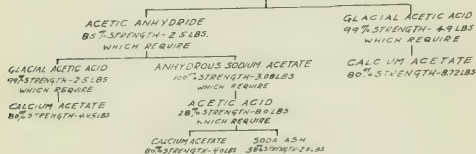
According to the studies of Doctors Henry and Camille Dreyfus the highly viscous cellulose acetates, which are commercially the most valuable, are obtainable by acetating cellulose under conditions which give rise as an initial or preliminary product, an ester insoluble in chloroform but soluble in alcohol-chloroform, and at the same time dissolving in acetone, a product discovered by them.

Factories were erected under their supervision in Switzerland, France, Italy, England and the United States, and it is to the products of these factories that the Allies were indebted primarily for their supplies of cellulose acetate for dope for airplane-wing coatings in the struggle so recently ended.

The United States Bureau of Aircraft Production, in their allotment of raw materials for cellulose manufacture during the war, calculated that for each pound of cotton or other form of cellulose, one and one-half pounds of finished cellulose acetate should be produced.

The following scheme indicates the cycle of processes and products concerned with the production of one pound of acetylated cellulose, it being remembered that there is a possible recovery of 3.36 pounds of 100 per cent. sodium acetate from each pound of cellulose acetate produced.

TO PRODUCE ONE POUND OF CELLULOSE ACETATE
REQUIRES



Industrial Uses of the Acetylated Celluloses

With the exception of uses in the dry state, there are few applications of nitrated celluloses in which the corresponding acetates have not been found of value. In the manufacture of cellulose-ester plastics typified by celluloid, as yet no body or combination of solvents and plasticizers has been found which will impart to the acetylated celluloses that degree of thermoplasticity which camphor gives to nitrocellulose. There is a wide and earnest search now being instituted through the entire domain of liquid and solid solvents in an endeavor to solve this question. Solvents by the hundreds have been patented for this purpose, each, however, lacking in some essential characteristic.

When such a solvent is found, the uses of nitrocellulose in the moving-picture industry for the backing or support of continuous films will undoubtedly be precluded by legislation on account of their greater inflammability. Triphenyl phosphate, the xylenesulfonamides, resorcinol diacetate, pyrogallol triacetate, acetin, hexanols and hexanones have been described for this purpose, but they have been lacking in essential characteristics. It would appear that the successful solution of this problem upon which so many are now engaged must include the use of pressure and heat in conjunction with the solvent or plastifying action of the solvent or solvents.

In the manufacture of fluid cellulose acetate mixtures as bronzing liquids, lacquers, artificial leather coatings and waterproofing solutions for the treatment of textiles, the present cost of production of the cellulose acetates in many instances precludes their use in

direct competition with the corresponding nitrocellulose solutions.

As a protective covering for the canvas used on aeroplane wings, immense quantities of acetate lacquer were used in the recent conflict. The official dope for this purpose as used by the United States Bureau of Aircraft Productions consisted of cellulose acetate 4.5 ounces per gallon, with methyl acetate, ethyl alcohol, diacetone alcohol, methyl acetone, and relatively small amounts of triphenyl phosphate, benzyl acetate and benzyl benzoate as plastifying bodies, and containing in addition, phenol as an antiseptic, naphthalene as a fungicide and urea as an anticid. This was known under the official name of "Scac" and was used in immense quantities both in observation and bombing planes. There is no doubt but that the use of cellulose acetate in such immense quantities during the war furnished a permanent and far-reaching impetus to this industry.

The official British dope or varnish for this purpose, and known under the name of Rafite, comprised in one form, cellulose acetate combined with triphenyl phosphate, benzyl alcohol, methylated spirits, acetone and benzol. In the cellulose acetate employed by this Government for aircraft wing coatings, it was found that if the solvent power of acetone be arbitrarily established as 100 for cellulose acetate, then that of calcitone (methylene ketone) is 65, ethyl formate 120, and methyl acetone 55.

Borzykowski and others have described artificial bristles made of cellulose acetate solutions forced through minute orifices into a coagulating medium and then cut to size after undergoing a strengthening process. For the preservation of maps and other documents which are exposed to the elements or are to be subjected to much handling, cellulose acetate dissolved in a mixture of low-boiling solvent as acetone with a smaller amount of higher boiling solvent as diacetone alcohol and attenuated with a cheaper non-solvent as commercial benzol, has been extensively used.

For the toughening of incandescent mantles, in photography both for plates and for continuous films, the manufacture of automobile wind shields, phonograph records, and the capping of bottles, acetylated cellulose is finding increased fields of usefulness. The coating of cigar tips, artificial sponge, imitation gold leaf, gilding of lace, the manufacture of artificial pearls and the coating of skins and hides are other uses for which patent protection for the acetylcelluloses have been granted.

Acetate Silk

All the artificial filaments, with the exception of those produced from acetylated cellulose, are in their final analysis some form of hydrated and reverted cellulose. The cuprammonium silks are combinations of cellulose and copper in which the latter is removed before the product is in the marketable form. The viscose silks first pass into the form of a cellulose sulfo-carbonate (xanthate) and are then broken down into cellulose. The nitrocellulose silks have the nitrogen removed by a process of denitration in order to diminish their inflammability, and thereby lose roughly a third of their weight.

On the other hand, there is no such finishing process required in the manufacture of acetate silk. The acetylated cellulose is first dissolved in a mixture such as acetone and benzene, the solution repeatedly clarified by filtration, and then the solution is forced through tiny apertures into a coagulating medium and reeled into hanks, bleached and dyed in a manner quite similar to the treatment of natural silk. One difficulty which

has seriously handicapped this industry has been the difficulty of dyeing uniformly acetate silk, but this apparently has been overcome recently as the result of the experiments of H. Dreyfus, in which the usual substantive and basic dyestuffs may be employed in dyeing by subjecting the acetated silk to a preliminary treatment as by a thiocyanate bath.

The practically limitless possibilities of an artificial silk which will simulate the properties of natural silk in a high degree is practically limitless. Up to the present, 150 denier is about the limit in fineness of this silk which can be made commercially, although much finer counts have been produced on a semi-commercial scale.

Cellulose Ethers

The recent researches of Dreyfus, Lilienfeld, Suida and others have unfolded a new class of cellulose bodies, the so-called cellulose ethers. Whereas the acetated celluloses may be said to represent the acid radicle in displacement of one or more hydroxyl groups in the cellulose aggregate, the cellulose ethers are cellulose in which the same hydroxyls have been replaced by alcohol radicles (alkyls as methyl, ethyl or benzyl). Thus we have methyl and ethyl celluloses dissolving readily in acetone and a great variety of readily obtainable solvents, the solubility of which can be governed at will by the nature of the alcohol radicle introduced or by the number of alkyls substituted for hydroxyls in the cellulose molecule.

These bodies are prepared by the replacement of hydroxyl hydrogens in cellulose or its conversion products by alcohol radicals, and only await less expensive methods of preparation to enter into direct competition with the better known cellulose acetates. They are white, stable, amorphous powders and have no acid radicle to split off and interfere with their neutrality—an important point. The penta-ethylcellulose is perhaps the most definitely characterized at present, and may be prepared by taking that form of cellulose soluble in alkali, such as is obtained in the regeneration of cellulose from viscose, or from cuprammonium or zinc chloride solutions of cellulose.

To 1200 parts of a solution of such cellulose in caustic soda, and containing 100 parts of cellulose to 100 parts of caustic soda, are added 100 parts of a 30 per cent. solution of sodium hydroxide. The liquid is then heated moderately and 100-200 parts of diethyl sulphate gradually added during several hours, with frequent agitation. To the mixture after several hours' heating on the water-bath, additional diethyl sulphate is added. After a further period of heating, the ethyl-cellulose may be precipitated out by diluting the mass with water. After washing free from reacting chemicals it is dried at a low temperature and is then found soluble in acetone, chloroform and acetylene tetrachloride. By carrying the reaction to its maximum, products soluble in cold water may be obtained, but of no technical significance.

The benzyl derivatives, which as yet have been imperfectly studied and offer most interesting commercial possibilities, are readily soluble in acetone and the cheaper solvents. The technical drawback at present to the extensive utilization of these cellulose ethers is the cost of diethyl sulphate and the large amount required for etherification.

The combination of etherification and esterification, whereby etherified cellulose esters, or esterified cellulose ethers such as ethyl cellulose acetate, with their undoubtedly wide industrial applications, is apparently a field which, as yet, has been but approached.

Possible Future of the Cellulose Esters

Synthetic methods for the manufacture of acetic acid and acetic anhydride which will compete favorably with the cost of nitric acid; the discovery and application of a suitable thermoplastic body to be used in conjunction with cellulose acetate to induce those valuable properties of plasticity as given by camphor to the corresponding nitrocelluloses; and the reduction to a more rigid manufacturing control of the processes of acetalization and subsequent partial hydration processes, undoubtedly would cause the acetylcelluloses to replace permanently the nitrocelluloses in the majority of fields of the peaceful arts.

The elaboration of methods of formation of methylating, ethylating and benzylating agents of especial applicability to cellulose in ether formation, together with the wide range of solvents which are useful for these cellulosic ethers, would undoubtedly greatly augment the usefulness and extend the commercial application of these organic ethers and esters, which as yet are but in their infancy, and for which the potentialities are practically limitless.

Reorganization and Plans of the Eastman Kodak Company

Two certificates filed August 24 in the office of the Secretary of State in Albany show that the Eastman Kodak Co. of New York has taken the first steps in putting into effect its plan of reorganization and recapitalization, which has been contemplated since the settlement of the Government dissolution suit. One of the certificates shows that the corporate powers and purposes of the company are to be extended and the other that the existence of the company has been made perpetual.

On July 1 the New York company resumed the selling of the goods manufactured by it, and the Eastman Kodak Co. of New Jersey became again, as originally, merely a holding company, owning all the stock of the New York company and of the various subsidiary companies in the United States and abroad. It is planned to increase the authorized capital of the New York company so as to provide for an issue of Preferred stock and an issue of shares without par value. These steps will probably be taken between now and January 1, and the whole reorganization completed soon after that date.

The capital stock of the Eastman Kodak Co. of New York is only \$1,000,000 now. How much this will be increased has not been decided, or, at least, has not been announced.

The Eastman Kodak Co. of New York will enter a new field, viz.: the developing and printing of motion picture films. For this purpose it has purchased three printing and developing laboratories: (1) the G. M. laboratory, Long Island City, with a capacity of 3,500,000 feet of motion picture films a week; (2) the Paragon, situated at Fort Lee, N. J., capacity 1,000,000 feet a week; (3) the Sen-Jacq laboratory, also situated at Fort Lee, N. J., not yet quite completed. The building itself is erected and the installation of machinery is progressing so rapidly that it probably will be ready for operation this year. This Sen-Jacq laboratory will be the most complete and up-to-date of its kind in the world and will have a capacity of 7,000,000 feet a week.

The Colorcraft Corporation, 25 West Forty-third street, New York, manufacturer of colors, chemicals, etc., with laboratory at 203 West Fortieth street, has filed notice of increase in capital from \$500,000 to \$600,000.

The Past Year in Industrial Chemicals

By Guy A. Gardner

Manager, Chemical Department, M. Gottesman & Co., Inc.

A REVIEW of the industrial chemical market shows a year of changing conditions due to the reaction from a period of inflated prices. Induced by a demand of proportions never before experienced in the trade, together with shortage of labor, transportation troubles and other difficulties which interfered greatly with production and satisfactory delivery service, prices rose to an unprecedented level.

The unusual demand stopped almost as suddenly as it began, since when we have been going through a period of readjustment which has been a severe test of the fortitude of the entire chemical industry. The instability of prices and the difficulty of sustaining values in the face of a constantly lessening demand reduced operations to a minimum and developed a feeling of pessimism that has been hard to overcome.

Prices dropped all along the line, in many cases declining below actual production costs. Present market quotations would seem to afford domestic buyers opportunity to secure their chemical requirements at price levels that can hardly go lower. There is no doubt that the chemical industry has done everything possible in the way of price reduction to restore a normal market and to make it possible for consumers to purchase on a basis that will enable them to go ahead on safe and sound lines. Similar action in practically all other manufacturing lines has brought about a much healthier condition and all that is now needed to start things moving is for everyone to get on the job with a renewed feeling of confidence all around.

The demand for chemicals for export also greatly decreased due largely to the adverse foreign exchange situation which tended to increase the domestic business depression. It seems unlikely that this soon will be remedied. However, there are some encouraging features in the export field notably the revival of buying by the Orient, especially Japan where business of considerable volume has developed lately in several staple chemicals.

The decline in values of exports of certain typical chemical products, as reported by the Department of Commerce, is shown in the following table:

	June, 1920	June, 1921	Per cent decline
Acids	\$ 565,347	\$141,512	74.7
Dyes and dyestuffs.....	3,851,180	605,096	84.4
Tanning extracts	343,913	114,040	66.6
Soda salts	2,404,076	547,252	77.0
Potash salts	383,602	37,757	90.1
Lime	158,103	56,945	64.0

Everything should be done to retain our foreign trade in chemicals which grew to such great volume during the war years and which is vitally necessary to the continued success of the chemical industry in the United States. Chemical manufacturers have increased their production capacity during the past few years in order to take care of the increased foreign demand and the curtailment of production does not proportionately curtail overhead charges, depreciation of plants and machinery. An increased foreign trade in chemicals will keep our plants working and enable domestic consumers to secure the advantage of lower prices made possible by maximum production.

The revival of business is making fairly steady progress. Many problems which have retarded the resumption of buying by domestic consumers during

the past year are in a fair way to early solution. If government action on the tariff and taxation can be hastened we surely may expect greatly improved business conditions. We look forward to a decided increase of the consuming demand during the fall and winter season.

The writer confesses to being incurably optimistic about the future of the chemical business in the United States. It is well to know that a large and flourishing chemical industry is necessary to the future welfare of our country, and there is every reason to believe that we are on the threshold of an era of great business prosperity. Our chemical industry will be an important factor in this development and will get its full share of the good times that are to come.

The Service of a Government Administrative Research Chemist

The transfer of the activity of Dr. Carl L. Alsberg from the directorship of the Bureau of Chemistry, Department of Agriculture, to that of the departments of production and distribution of the Food Research Institute recently established at Leland Stanford University, has evoked a letter of appreciation unique in its sincerity and merit of bestowal.

In accepting formally the resignation of Dr. Carl L. Alsberg as Chief of the Bureau of Chemistry, Secretary of Agriculture Wallace wrote him as follows:

"Permit me, in accepting formally your resignation, once more to express my sincere regret that the Government and this department will no longer have the benefit of your services.

"Your nine years in the department have been fruitful years. You have attained a leadership in scientific work not alone in this department, but in the larger field seldom reached by men of your years. The tender of the important position which you have accepted is evidence of this.

"Your administration of the food and drugs act has been characterized by tactfulness, fearlessness, justice, and common sense, and you have, therefore, commanded the confidence and respect both of those who have come under the law and of the great public whose health you have so zealously protected. Your work in this field has been an inspiration which I hope will continue with us.

"It is not often that one attains such outstanding eminence in both research and administrative work.

"We shall all miss you here; especially I shall miss your wise and sane counsel from which I have profited very much in the rather trying task of undertaking to qualify for a difficult and important work. I wish that you might still be within call.

"Notwithstanding our regret that you are leaving the department, all of us here rejoice in the opportunity that has opened for you to pursue important research in a field in which you have such a great heart interest. We are expecting much of you; we are confident that you will make large and valuable contributions to the national welfare.

"I know that I express the feelings of everyone in this department when I say that our very best wishes go with you, and if at times you find that we can be of help in the work you are now undertaking, we shall expect you to call upon us with full assurance of a prompt and sympathetic response."

II. Muscle Shoals and Henry Ford

Condemnation of the Ford Proposal by the Merchants' Association of New York.

By F. B. De Berard, Director, Bureau of Research, and A. M. Travers, Head, Legislative Service Bureau, Merchants' Association of New York

AS a committee representing the Merchants' Association of New York we have filed with Secretary of War Weeks, a protest signed by William Fellowes Morgan, president of the Association, against the acceptance of Henry Ford's proposal to acquire the government nitrate property at Muscle Shoals.

The existing properties which Mr. Ford proposes to buy were acquired and constructed by the United States primarily as a war necessity for the production of nitrates required for explosives, and secondarily with a view to their possible utilization by the Government in peace time for the production of fertilizers at low cost, in order to promote the Nation's agricultural production.

Mr. Ford's Proposal

The ostensible objects to which his proposal is directed are twofold:

(a) To preserve in effective condition for operation the Government nitrate plants now existing at Muscle Shoals, as an imperative military necessity for the production of explosives in time of war.

(b) To improve those plants by constructing additional and very extensive hydroelectric works, thereby substituting very cheap electric power for relatively high-cost steam power, and thereafter to operate a part of the plant for producing fertilizers at low cost.

Military Purpose Served

The military purpose, which was the prime consideration, has been accomplished. At a cost of \$87,365,135,* the Government now has nitrate plants of great capacity, completed and ready for immediate operation, without further outlay except the annual cost of upkeep. It is this property which Mr. Ford proposes to buy outright for \$5,000,000.

The secondary purpose, the production of cheap fertilizers, is not realized. Cyanamid, the chief product of the Government Nitrate Plant No. 2, although rich in nitrogen, and suitable for explosives manufacture, is not readily adaptable as a fertilizer to American farming methods. A further process of manufacture is required so to adapt it, and for that a very considerable modification of the plant and a large additional investment is necessary. The existing plant is operated by steam power at high cost. Low-cost production requires the substitution of very cheap hydroelectric power. To provide such hydroelectric power will require the investment of approximately \$77,000,000 additional capital and the development of dams and power plants at Muscle Shoals.

Essence of Mr. Ford's Offer

Mr. Ford's proposal is in essence:

That the Government shall sell to him for \$5,000,000 its existing nitrate plants, which cost more than \$87,000,000, and are, without further outlay, entirely serviceable for military purposes;

That to enable him to produce low-cost fertilizers the Government make the additional investment required to construct hydroelectric power plants in addition to the existing complete steam power plants;

That such hydroelectric power plants be leased to him for one hundred years (with privilege of renewals) for \$1,680,000 per year (6 per cent. on \$28,000,000);

That through annual sinking fund payments of \$46,547 he will provide for the amortization of \$45,000,000 of the Government's capital investment in the hydroelectric plants.

Estimate of \$28,000,000 Too Low

Seventeen million dollars have been spent by the Government upon Dam No. 2. Dam No. 3 has not yet been begun. Mr. Ford's proposal assumes that an additional outlay of \$28,000,000 will complete both dams, making the aggregate capital cost of the two \$45,000,000. He proposes to pay interest of 6 per cent. on the new investment to the extent of \$28,000,000, but not upon the preceding investment of \$17,000,000. He further proposes to provide for the amortization of the assumed entire capital cost of \$45,000,000.

Accepting as approximately correct the most recent estimates of the Government engineers, the additional immediate outlay required to complete the hydroelectric power plants will approximate \$60,000,000, instead of the \$28,000,000 to which Mr. Ford limits his obligation. On the same basis, the entire capital investment of the Government will be approximately \$77,000,000 instead of the \$45,000,000 to which Mr. Ford restricts his amortization liability.

Colonel Cooper's Estimate

We call your attention to the following testimony of Colonel Hugh L. Cooper, consulting engineer of the War Department, at a hearing before a subcommittee of the House Committee on Appropriations (February 14, 1921, p. 3):

Colonel Cooper—* * * We have recently completed as careful an estimate as it is possible to make of the cost of the work (on Dam No. 2), based on the unit costs that have been developed by the Engineering Department of the United States Army. We have checked the quantities that will be in the finished structure as closely as those quantities can possibly be checked at this time. We have examined the cost records that have been developed up to date. Based upon that sort of an investigation, I am of the opinion that when the dam is fully completed, and all the power units installed therein, that the maximum cost of the work will be \$50,000,000, including the locks.

General Taylor of the Army Engineers concurred in Colonel Cooper's estimate (Hearings, page 6).

Colonel Cooper's estimate was based on the installation of hydroelectric equipment to produce 550,000 horsepower (Hearings, page 39).

The Ford proposal requires the installation of "hydroelectric facilities and equipment for generating 600,000 horsepower," or 50,000 horsepower more than included in Colonel Cooper's estimate. This would increase the required investment by approximately \$1,000,000.

Applying to Dam No. 3 (not yet begun) the units of cost used by Colonel Cooper in his estimate for Dam No. 2, the cost of the former would reach approximately \$26,000,000.

Actual Aggregate Cost

The aggregated cost of the two projects when completed would thus be approximately as follows, on the basis of the most recent official estimates:

Dam No. 2—	
Colonel Cooper's estimate.....	\$50,000,000
Cost of additional machinery not included in Colonel Cooper's estimate.....	1,000,000
Dam No. 3—	
Computed on basis of Colonel Cooper's estimate for Dam No. 2.....	26,000,000

Total estimated cost two plants..... \$77,000,000

*Rep. No. 998, House Com. on War Expend., 66th Congress, 2nd Sess., p. 60.

Deducing from this sum of \$17,000,000 already expended, the remainder, or \$60,000,000, represents the additional capital investment required.

Would Amortize Only \$45,000,000

Mr. Ford's proposal provides for the amortization of but \$45,000,000, as against the \$60,000,000 new investment required and the \$17,000,000 investment already made, thus leaving the Government to stand an ultimate loss of \$15,000,000 of the new capital required, in addition to the loss of the \$17,000,000 already invested, or a total capital loss of \$32,000,000. The new investment will not recoup past losses, but will nearly double them.

It is obvious that such investment under these conditions is not a wise or sound financial transaction.

Additional Outlays Involved

Moreover, there are additional Government outlays required by the Ford proposal, the amount of which is very considerable, but which we do not attempt to estimate. Among them are the following:

Cost of acquiring 80-mile right-of-way for Transmission Line.

Cost of acquiring title to land and site occupied by steam plant and other buildings at Warrior River.

Mr. Ford's rental proposal is not more attractive. He proposes to pay 6 per cent. interest on \$28,000,000 new money, but not on the \$17,000,000 already spent. This is equivalent to an annual rental charge of \$1,680,000 for property which, if completed, will have required a capital outlay of \$77,000,000, or of \$60,000,000 if only the money yet to be invested be considered.

Large Annual Deficit Involved

The annual interest cost to the Government of \$60,000,000 additional capital investment at 5 per cent. would be \$3,000,000; on \$77,000,000 it would be \$3,850,000. Thus each year the Government would pay out for interest from \$1,320,000 to \$2,170,000 more than it would receive under the Ford proposal.

Taking into account the actual capital investment, but adding interest only upon the proposed new capital (ignoring the capital charges upon the \$17,000,000 already spent), the account for the 100-year term would stand thus:

Outlay, 100 years—	
Capital investment	\$77,000,000
Interest, 6 per cent. on \$60,000,000.....	300,000,000
	<u>\$377,000,000</u>
Receipts, 100 years—	
From sinking fund payments and earnings	\$45,000,000
Interest 6 per cent. on \$28,000,000	168,000,000
	<u>213,000,000</u>
Net loss to United States.....	\$164,000,000

There is no pretense that this power development is essential to the Nation's military defense, inasmuch as that purpose can be fully served by the completed existing plant operated by steam power.

Its justification must be found, if at all in its assumed benefits to agriculture, through the provision of low-cost fertilizers.

Conditioned upon the provision by the Government of electric power at very low cost, through the development of the hydroelectric power plants discussed above, Mr. Ford undertakes the following obligation as to the production of low-cost fertilizers:

12. If the United States agrees to sell and the company purchases these several properties, nitrate plants, quarry, steam power plants, transmission lines, etc., and at prices and on terms mutually satisfactory, the company will operate Nitrate Plant No. 2 to approximately present

capacity in the production of nitrogen and other fertilizer compounds, with the following special objectives:

(a) To determine by research on a commercial scale whether by means of electric furnace methods and industrial chemistry there may be produced fertilizer compounds of higher grade and at cheaper prices than the fertilizer-using farmers have in the past been able to procure, and to determine whether in a broad way the application of electricity and industrial chemistry may do for the agricultural industry of the country what they have economically accomplished for other industries.

(b) To maintain Nitrate Plant No. 2 in a state of readiness to be promptly operated in the manufacture of materials necessary in time of war for the production of explosives.

Asks for Subsidy of \$164,000,000

Mr. Ford's offer in effect is that if the Government will subsidize him to the extent of approximately \$164,000,000 he will *experiment* to determine whether or not he can produce and sell fertilizers more cheaply than they can now be produced and sold.

The Government is to provide an installation for 850,000 hydroelectric horsepower.

Mr. Ford assumes only the obligation of applying an unspecified part of this power during an indeterminate time to *experimentation* in fertilizer production. There is nothing to preclude abandonment of the fertilizer experiments should the result be unsatisfactory. In the event of such abandonment Mr. Ford will have available for exclusively private purposes an 850,000 hydroelectric horsepower plant for a rental charge (interest and sinking fund payments) of but \$2.03 per horsepower year.

Would Serve Private Interests

Under such circumstances, all semblance of any public purpose will have disappeared, and the Government investment will have become an undisguised subsidy to an exclusively private interest.

Moreover, even should fertilizer production be continued, much, if not most, of the power developed at Government's cost would be available, and would be used, for strictly private purposes, to the detriment of competing unsubsidized industries.

Should Mr. Ford, on the other hand, by reason of the subsidy granted him, be able to produce fertilizers at substantially less than the market prices obtained by private industry, the result, in our opinion, will not be to increase the aggregate supply of nitrates so essential to this country's prosperity, both for military purposes and for rendering the soil more productive.

The reason is obvious; the artificially low prices thus resulting would make it impossible for private capital to continue in the production of nitrates and fertilizers, and the total volume of such materials would thereby be greatly reduced below the present volume; or, as an alternative, the Government would be under the necessity of either permitting a complete monopoly by the Ford interests or of subsidizing other manufacturers in order to insure the required supply. Either of these alternatives is odious to the American people.

Public Intolerant of Monopoly

Public sentiment is extremely resentful of monopoly, and, urged by that sentiment, the Government, through the Federal Trade Commission, has strenuously sought for several years past to prevent even its semblance. The principle of subsidy to private interests is still more objectionable, particularly when so applied as to give artificial advantage to a special interest, and thereby to attack the legitimate operations of private capital.

Research in industrial chemistry for the purpose of fixing nitrogen derived from the atmosphere is now in progress with great assiduity on a wide scale, through the medium of private capital, in the hope and with the practical certainty of greatly increasing the supply of

nitrate and decreasing their costs. The production from by-product coke ovens, a principal present source of supply, has recently increased fourfold.

The American modification of the Haber process, which successfully met Germany's nitrate needs during the war, is already in successful operation in this country, and widespread experimentation by other industrial plants is in progress.

Would Drive Off Private Capital

All that can possibly be accomplished by the Ford interests in the way of developing effective and cheaper methods of production is already in process of accomplishment. In the event that the Ford interests are subsidized, it is inevitable not only that capital will cease further investment in a field where it is subjected to the destructive effect of subsidized competition, but that the vast volume of capital already employed in this field will retire as speedily as possible.

It is the firm conviction of the Merchants' Association of New York, reached after long and intimate study of the subject, that under no circumstances is the Government justified in invading the industrial field, either directly or by means of a subsidy to a single interest, under conditions which will give it a great competitive advantage over other private capital.

Nitrogen Fixation in Great Britain

THE Nitrogen Products Committee of the British Ministry of Munitions has supplemented its final report of the progress of the art of nitrogen fixation by a series of statistical tables covering the period from the latter part of the war up to the present time, and embracing the world's resources in nitrogen products, the Chile nitrate industry, the production of nitric acid and sulphate of ammonia, the synthetic ammonia process during the war, and the cyanamide industry.

It is estimated that the world's capacity for the production of fixed nitrogen amounted last year to 1,561,000 tons, of which about 57 per cent. was attributable to natural sources, such as Chile nitrate and the by-product industry, and the remainder to artificial fixation processes. The London *Times* in interpreting these statistics from the standpoint of the interests of Great Britain, says:

The most striking, and in some ways the most disquieting, feature of the statistical supplement to the Nitrogen Products Committee's report is the great increase in the world production of fixed nitrogen, and of the fact that of the fifty plants in operation throughout the world, not one is established in this country and only two are to be found within the Empire. Canada has one arc process plant with a maximum capacity of 800 metric tons a year and a cyanamide process plant estimated to be capable of 12,000 tons. Thus, of the world's total estimated capacity for 1920 of 671,300 tons, the British Empire commands only 12,800 tons.

A fuller examination of the position reveals the conclusive predominance of Germany in this field. While Norway outdistances all rivals in the arc process, producing 30,000 tons out of a total of 38,300, Germany, taking the three processes together, produces nearly twice as much fixed nitrogen as the rest of the world. Of the 325,000 tons credited to the cyanamide process, Germany commands 120,000, while under the synthetic ammonia process she has a capacity of 300,000 tons, and the only rival is the United States, with the almost negligible figure of 8,000. Put in a sentence, Germany can produce by fixation processes 424,000

Ford Proposal Should Be Rejected

We believe, therefore, that the Ford proposal should be rejected, both on financial grounds and because it covers in effect a huge subsidy to the Ford interests, of a nature seriously destructive to the development of industrial chemistry in this country, and particularly to the production of an increased supply of nitrates, necessary both for military protection and agricultural development.

We fully recognize the need of promoting in every proper way the fertility of agricultural lands through the provision of cheap and abundant fertilizing materials, but we are firmly convinced that the result of accepting any proposal based upon a Government subsidy to a single interest will tend to decrease instead of to increase the supply, and will therefore fail of its purpose.

We further object to this proposal because it calls for a very large immediate outlay of public funds at a time when the need for public economy is extremely urgent. Nothing but an imperative public necessity can justify present additions to the existing financial burdens by which the people are oppressed. It certainly cannot be contended that the project under consideration is required by any public exigency.

metric tons of nitrogen a year, and the rest of the world can produce only 237,000 tons, of which this country (Great Britain) produces none.

Our one internal source of fixed nitrogen is therefore by-product works, and even there we produce only 100,000 tons against Germany's 150,000. As a net result our internal resources—that is, the resources on which we should have to rely if all colonial and foreign supplies were cut off—represent 2,240 tons of fixed nitrogen per million of population, while Germany's resources amount to 8,830 per million of her population.

It is sometimes suggested that our inaction in this field may yet prove of advantage, since by waiting until experiment had demonstrated the best process, we might adopt it and then pick up our competitors. The history, however, of our loss of the synthetic dyestuff industry, which began in 1856 with Pekin's discovery of mauvine and still flourished for twenty years after, gives little support to this complacent theory.

The plain truth is that while other countries, especially Germany, have carried their experimental work well into the productive and commercial stage, we are still engaged in constructing plants and debating the merits of the processes of German, French, and other chemists. The synthetic ammonia factory at Billingham, designed to manufacture about 60,000 tons of ammonia nitrate annually for war purposes, was begun by the Ministry of Munitions early in 1918, but at the time of the Armistice was only very little advanced. This is now being redesigned by Brunner, Mond & Co., to manufacture fertilizers, and a subsidiary company is at present concentrating upon designs for an initial plant to produce twenty-five tons of nitrogen per day or about 6,000 to 7,000 tons annually.

Cumberland Coal Power and Chemicals, Ltd., have purchased the British rights in the French process by Georges Claude, and the British Cyanides Company are continuing at Birmingham their large-scale experiments on fixation of nitrogen by the barium process. The fact remains, however, that we are still in the constructional or experimental stage, while Germany far outdistances all competitors in actual production.

"Bugs"

A Dissertation on a Well-Known Character in Every Chemical Plant

By C. R. Dooley

Manager, Personnel and Training, Standard Oil Company of New Jersey

EVERY "plant" has its "Bug"—the one man who, in spite of little or no special training, has more patents and processes and company procedures to his credit than any other man about the place. Many say this is not in spite of little education, but because of it.

At any rate, the "Bug" is a most essential man and we may well consider how to produce more of his kind. Will an engineering education do it? This is a big question. Indeed, as a nation we may ask what are we producing as a result of enormous expenditures for special education? Let me ask the question another way. How can the simple fundamentals of scientific knowledge and the habit of logical thinking be acquired without stifling imagination, originality and courage? It would seem that all the scientific knowledge in the world had better not be learned, if in the learning comes a sense of finality, of completeness of scientific information, of contentment with applying the wisdom of others.

At least it is true that at the basis of every industry lies some "Bug" who defies traditions, who cuts across lots, who would not be called foolhardy yet has the courage to follow his natural hunches, who is almost uncanny in his insight along certain lines, who makes new paths rather than follows old ones. It is good to have a few fools around to rush in occasionally. But are they fools, and are they untrained? I think not. If they are college-bred, they have somehow preserved the ability to take their formal education incidentally and not too profoundly and, without being conceited, have, first of all, supreme faith in their own powers. If they are unschooled, they have nevertheless picked up by their own efforts just those choice bits of information which they need; and they have learned by experience to think straight.

Leonardo said of himself that not being hampered by learning the thoughts of other men, he had but to ask himself questions about the things he saw all around him and then proceed to find the answers by observation and experiment.

In our educational processes we seem to have forgotten that all men are created different and that each needs a different treatment. Boys and girls all go through the same machine and whatever spark of genius some possess is often quenched in the process of rounding off.

The machine produces splendid routine workers and faithful scientific servants, but few "Bug" leaders. The Psalmist says: "Train up a child in the way he should go," but we prefer to train him in the way we wish him to go.

In addition to this type of pure research "Bug" free to produce new ideas in his own way, industry needs the development man who has a sense of adaptation, of co-ordination of values, of planting the seeds produced in the research laboratory and growing them into well organized plants. The development man is also something of a "Bug," but more patient, more commercial than the research man.

However, both the research man and the development man are discovered and not made. Then they are in one way or another developed through the study of fundamental principles and their free application to new

and changing conditions. Even the facts of today they view as probable discards of tomorrow, and most of all these men have been able to adapt the things life has brought to them, according to their individual needs, and have discarded the things they could not use in spite of the urge of social custom and loving friends. They have dared to be themselves.

When our technical schools can approach each man to help him to discover and develop himself in the way nature intended he should go, without regard to formal standing, years of credit, diplomas, etc., with only the single standard of extreme excellence within his field, then will we produce more men and women of genius not only as inventors of technical devices, but as organizers, financiers, world traders, and men of letters.

A boy has a gift to create poetry and stories of gripping human interest. What use has he for algebra, especially the kind that endows only the letters X and Y of the whole alphabet with the mysterious power of representing unknown quantities.

The world would be happier if we were all "Bugs," each according to his native talent; especially if we knew enough about the work of other kinds of "Bugs" to be appreciative and tolerant.

If our social life, public school, Sunday school, church, home life, college life, industrial life, and all the rest of our social influences encouraged an investigative, inquiring habit of mind; if we taught young people that while whatever is right today, it probably will be wrong tomorrow, we would develop a much larger number of "Bugs" and solve the problems of the world more rapidly. How long will we guard our pet ideas and prevent children from cutting across lots to new truths we little dream of? We are mostly wise in our own conceit.

I pray you, give the "Bugs" a chance and judge them by their own records and not by their conformity to established rules.

Salvaged Picric Acid for Land Clearing

The distribution of 12,500,000 pounds of salvaged picric acid by the Department of Agriculture through the Bureau of Public Roads, at the cost of packing and transportation, to land owners of the various states, in accordance with the area of cut-over land therein, is relief from the annoyance of a heritage of war that will not be without its influence on the sale of commercial explosives. The picric acid has been prepared for distribution by drying and packing in double-dipped paraffine cartridges weighing six ounces. These cartridges are packed in wooden boxes each containing 100 pounds of the explosive. One of these cartridges is about equal in strength to an eight-ounce cartridge of the commercial dynamites used for agricultural blasting. Picric acid is not affected by the ordinary temperatures encountered in this kind of blasting operations.

* * *

The hard rubber used in electrical instruments sometimes becomes discolored due to long exposure to light. Its original blackness can be largely restored by rubbing the surface with carbon bisulphide.—*Pyroelectric Bi-Monthly Bulletin*.

Technical Sales Service to the Dye User

By Charles H. Stone

Vice-President and Sales Manager, Atlantic Dyestuff Co.



CHARLES H. STONE
Vice-President and Sales
Manager, Atlantic
Dyestuff Co.

THE propriety of the technical sales service rendered by the American dyestuff companies has been questioned by a group of our textile finishers. Whether the attitude of the dye makers is wholly justified or not may be determined by a review of the service rendered.

Ever since coal-tar dyes were introduced into America, the seller has supplied more or less technical sales service. Before the literature relating to the application of coal-tar dyes became abundant and widely distributed, it was certainly necessary, as the original manufacturers of Primuline in England found, to supply technical service in promoting the sales of these products, which service has contributed largely to the public benefit.

The great majority of dyestuff users, whether textile manufacturer, leather tanner, papermaker, or what not, are not in position to make laboratory or experimental tests of the dyes they require, and unless their suppliers have the facilities for matching shades, working up new shades, testing samples, etc., these dye users are placed at a very great disadvantage as against the dye users having laboratory facilities for making experimental tests.

And as the businesses requiring dyes are of such a nature that they may be conducted successfully on a very small scale, it would seem an injustice for the small dye user not to have available the facilities possessed by his more powerful brother.

The demonstration of dyestuffs in the dye-house has been one of the means leading up to the remarkable development of the dye-making and dye-consuming industries. It is not hard to see that if our dye makers and dye users had not worked hand in hand in the practical application of the new colors, it would never have been possible for these two industries to have attained the very high state of perfection and efficiency which have given us the unusual and artistic colorings that add so much to the esthetic side of human existence.

The propriety of a dyestuff maker working hand in hand with a group of prospective dye users in the establishment of a new dyeing and finishing plant may be questioned, especially from the standpoint of the established plant, which is also more or less dependent upon the dye maker for its materials. I conceive this phase of technical sales service to be one between the

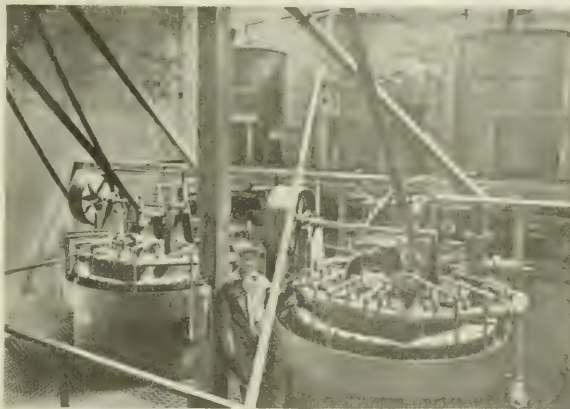
maker and his customer, more than one of trade policy.

The application of dyestuffs is governed by so many uncertain elements that trouble is inevitably experienced in many cases, and it would certainly be unfair to the dye user if the dye maker did not supply the most expert information and assistance in overcoming these troubles, whether they result from the dye, the water, the method, or what not.

This phase of technical sales service is certainly supported by the merchandising methods which are followed by manufacturers in many other lines; for instance, some of the prepared roofing must be applied under the direction of the manufacturer, while the textile machinery people maintain trained mechanics wherever necessary to keep their machines in perfect order.

Usually, we find the dye makers very well informed regarding the type of equipment best suited to the production of the best results with their dyes; in fact, the type of equipment and method of application largely control the results to be obtained with many colors, and it is certainly not amiss that information regarding these be supplied to the user.

If the dye maker does not supply the technical sales service necessary to aid the dye user in both determining relative values of dyes and the best methods of application, the dye user unequipped with experimental apparatus will have to go to a public laboratory for the information he requires to check up properly his materials, and find their best methods of application. If this has to be done, the textile finisher employing twenty men, or the textile manufacturer with a \$50,000 plant, is practically deprived of the opportunity of making



View of Vitrators in Plant of Atlantic Dyestuff Co. A potential arsenal, the attitude of politicians that would permit the destruction of the American dyestuff industry, is the result of the "trust-busting" movement, the result of the "trust-busting" movement, the result of the "trust-busting" movement.

the progress, and thus establishing himself, which is open to the large finishing works, or the million dollar textile plant, or tannery.

Another phase of technical sales service which may occur to some is the advantage accruing to the stronger dye maker, capable of supplying this service of the highest class, as against the small dye maker who e

ability to employ high class technicians, and send them wherever they may be required, is necessarily limited.

The answer here seems to be that the smaller dye maker is not likely to get under way unless he has some unusual talent in his plant, perhaps comparable to, or even better than, the talent to be bought by the richer organization. It would therefore seem that no actual injustice is done in such instances.

A review of the many angles of technical sales service seems not to condemn this practice. On the contrary, for the good of all, and having its warrant in the progress which cannot be made otherwise, every dye maker would seem to be justified in supplying such technical sales service as his facilities permit and his customers require. Here we have team work in that mutuality of service which is the sure basis of progress.

A Commercial Memorial to Herman Frasch

A Tribute to the Successful in Chemistry—For Success Means Service.

THE transfer of the administrative offices of the Union Sulphur Company to its own building at 33 Rector Street, corner of West Street, New York City, directs attention to the notable contributions to industrial progress of a chemist whose associates have memorialized in the name of the building.

There comes a stage in the development of our resources when we seek to fix in the public consciousness the place of men who have been in the forefront in the work of their exploitation, that those who come after may find inspiration in their attainments; and so we grant degrees and award medals to those who in exceptional measure have served their fellows.

No chemist in our time has surpassed Herman Frasch in the variety and value of his researches that worked directly to the material welfare of society in making possible that condition precedent to advancing standards of living, viz., ever-greater abundance of cheaper goods.

Industrialism like theology has its gallery of saints, and the test of election is identical.

That Frasch made money for his employers and himself is a measure of the reality of his service, and that his associates in a company that he established have named a commercial structure in his memory show that today distinction comes to those who strive to make life better in this world of which we are sure, in contradistinction to ancient practices as regards a world we know nothing about. It is impossible to estimate the retarding influence on human progress of this misplaced emphasis.

The outstanding characteristic of Frasch's experience, and therein its lesson to American industrial chemists, was the opportunism of his scientific interest and his faculty of using to the best material advantage what he knew.

In the petroleum industry forty years ago refining methods were a pressing problem when Frasch as a boy in Philadelphia turned from pharmacy to industry. His progress in this field, whose commercial development early fired the imagination of remarkable men, was an almost unbroken series of chemical engineering successes whose significance to history is suggested by all that cheap illumination means to man.

To inject steam into the earth to melt sulphur, and to

blow the fluid mass to the surface, meant more than a chemical engineering feat in which was displayed a practical resourcefulness greatly beyond the capacity of his fellows. It deflected the channels of commerce, dealt the Sicilian sulphur mining industry a blow from which it never will recover, and gave to America pre-eminence in the economical production of the fundamental heavy chemical.

The foundations of chemistry were laid by men who in speculation and research made discoveries whose significance and potentialities the primitive mind of the time failed to grasp. We are reaping today by the instrumentality of exceptional men the harvest of the work of the Fathers of Chemistry.

Frasch, impelled by an investigative mind and aided by a rare adaptability, translated into wealth beyond human estimation the results of research which had become the scientific commonplace. This is the significance of research to industry and of the provision of the conveniences and comforts of life by the industrialist scientist.

The American chemist has in the ambition, activity and accomplishments of Herman Frasch a challenge to his own enterprise. It should provoke self-scrutiny in the determination to emulate his material fecundity. Opportunities are no less today than they were in Frasch's time. Problems are solved only to disclose others that in time demand for their solution increasing application and aptitude.

Frasch brought to his work the rare combination of the chemist and the business man vouchsafed to but few, and which respective quality

in the usual run of men means the derogation of the other quality. If Frasch's life teaches anything to the American industrial chemist it is the desirability of cultivating an appreciation of the economic aspects of his work and of the chemist's relation to it.

We make our obeisance to the successful in chemistry, for success means service.

Dyestuff manufacture in Australia has been initiated by Australian Dyes Proprietary, Ltd., which has built a plant at East Richmond, Victoria, where it is expected that within a year the more common dyes required in Australia will be produced.



The Frasch Building
33 Rector St., New York



Application of Insecticides and Fumigates in Horticulture. Painting by A. H. K. Hammond. Courtesy of Dow Chemical Co.

THE variety of methods of distribution employed in getting agricultural insecticides from the factories to the consumers arises from the fact that plants manufacturing these articles are of so many different types and operate under so many different conditions.

Marketing Methods

Conditions surrounding the plants vary in many ways. Conditions of financing always influence to a marked degree marketing methods. For some firms the production of insecticides is their only function; for others it is of secondary importance and only a side line. The previous business of some companies prior to their taking up insecticide manufacture also has influenced their method of disposing of their finished product.

Though it is not always easily apparent the principle influence determining methods of distribution is financial. In the manufacturing and sale of goods there is a long time interval between the purchase of the raw materials and use of the finished product by the ultimate consumer. The financing of transactions over this space of time usually is conducted in one of two ways. The money may be furnished from either end of the route.

It would be quite natural to assume that the methods employed in the fertilizer industry would be duplicated in the sale of insecticides. In the fertilizer business the manufacturer furnishes the money for the transactions, allowing long-term credit to dealers who in turn do not obtain their money from the farmers until the sale of at least part of the farm crops.

Every manufacturer who has grown up rapidly from a small to a large business has realized with startling distinctness what this form of marketing and financing means. The capital required can come from only one place, his bankers, the final result being that every decision and every policy of the manufacturer's business has to be made with one eye on their banking accommodations. And for this reason the cost of credit really may amount to much more than the actual interest charged for the money.

At the very start of the insecticide industry this was realized by some manufacturers and strenuous efforts were made to break away from fertilizer sales

practice. This was quite successful especially among those whose sole business was the manufacture of insecticides. Not all, however, have done this.

Only a short time ago the treasurer of one of the largest corporations making insecticides, which has a convenient spout running into that fount commonly known as "Wall Street," made the off-hand observation: "One thing our firm does not have to worry about is money. We know where to get all we want of it at any time," and yet during the same conversation he expressed wonder as to how several small manufacturers could compete with them and hang on year after year doing business.

The answer of course is obvious. It is the small firms' absolute independence of action, ability to stop manufacturing for a time without large overhead losses and their wide form of distribution for cash.

The opposite form of financing is through the exclusive sales agency or commission house. This has been used almost entirely in the textile industry and not always to the manufacturers' benefit. A mill appoints a large wholesale or commission house as its exclusive sales agent. The wholesale house advances money to the mill on prospective deliveries of goods. But the wholesale house controls distribution and it is not long before the tail is wagging the dog.

This plan has been employed very little in the insecticide business, but a variation of it has been used by some. By this variation certain raw material is purchased from a dealer in chemicals on fair credit terms. The material is then rapidly made into the finished product which is then shipped to the chemical dealer's warehouse in exchange for more raw materials. This dealer thus becomes a distributing point for the manufacturer and handles the goods both coming and going.

The bulk of insecticide financing, however, has not adhered to either of the above methods with their attendant long-term credits or exclusive sales-agent methods of distribution. Sales are made direct to wholesalers, retailers and consumers. A schedule of prices being maintained for each class. The dealers carry the bulk of the stock instead of the manufacturer and most of this stock is paid for when received. A notable exception to this, however, occurred a year ago.

Some manufacturers confronted by the prospect of enormous sales of calcium arsenate in the South for combatting the cotton-boll weevil, shipped large quantities of this material into that locality on consignment. The sales did not materialize and the calcium arsenate is still down there tying up capital and it is the factory that is trying hardest to get it to move into the consumers' hands. All of which costs the *factory* money.

The wisdom of wide, rather than concentrated methods of distribution and letting the dealer carry the stock and the credit for many industries was brought forcibly to attention in what is understood as Henry Ford's latest coup.

Needing what even in these days was considered a staggering sum of money for a single manufacturer, he neatly transferred the problem from himself to the distributors, much to the chagrin of the group of bankers who had expected the grapes to fall in their lap in one bunch instead of as individual seeds presented to a multitude of small banks by the distributors throughout the country.

But it has not been financial considerations alone that have caused diversified methods of insecticide distribution.

Many of the later firms taking up this business already were interested in a large way in other lines. Several large paint manufacturers who have entered the business have naturally distributed their insecticides through their multitude of jobbing warehouses throughout the country. In these cases, however, they have run against a special problem in trying to use paint salesmen for selling insecticides.

The sale of insecticides is work for a specialist and the writer personally knows of several paint salesmen who have resigned their positions rather than attempt to sell these goods along with their paint line. Therefore, in such cases the general practice now is to distribute through the paint warehouses and jobbers but employ special insecticide salesmen to make the sales and keep contact with the buyers.

The previous business interests of a manufacturer also frequently influence his sales and distribution.

One manufacturer, previous to making a general line of insecticides, has manufactured lime-sulphur solution, which has a very seasonal demand, is hard to store and cannot be shipped economically long distances. Later, when he took up the manufacture of other products, as arsenates of lead and calcium, the policy necessitated by the requirements stated was still continued and he confines himself to comparatively small cash sales within a limited area.

Another concern manufacturing agricultural implements took up the jobbing of insecticides to accompany their spraying apparatus. This was largely advertising and catalogue business. When later they took up the manufacture of insecticides these methods were naturally continued to a great degree.

From the foregoing it is seen that for several reasons the distribution of insecticides has been through widely diversified channels. They are sold direct by mail order. They are sold in drug, hardware and seed stores, though strange to relate the amount reaching the consumer through the latter medium is far less than would be expected. Insecticides are purchased and distributed by farmers' associations. But by far the biggest outlet for these products is through the general country store.

Insecticides especially those in dry powdered form are frequently bought in bulk and repacked by jobbers. They are also manufactured for large dealers using the dealer's packages and label. Manufacturers

also buy and sell finished products among themselves when certain emergencies arise. Therefore, through sale and resale combined with repacking and diversified methods of distribution it is not always easy to tell just where the material was originally produced. This has led to some amusing incidents.

Some years ago a well-known insecticide concern wishing to increase its representation in a distant part of the country bought out the plant, trade marks and good will of a second insecticide company. This sale and the relationship between the plants were not generally known to the trade.

Plant Number Two had been supplying a certain jobber with several carloads of their product every year. After the combination it was decided, as the parent plant had a large stock of goods on hand whereas Number Two plant was well sold-up, that the former would make a bid for the jobber's trade.

But the jobber would have none of it. It was stated that they had thoroughly examined the goods of the parent house and found them unsatisfactory. They always had purchased from manufacturer Number Two and would do so again if its price was right. Therefore, to cover the situation the parent firm shipped several carloads of arsenate of lead to plant Number Two which labeled the product and transshipped it to the jobber who was well pleased with his season's purchase and considered it very fine goods.

The following is another illustration of the complicated distribution of insecticides.

We often are prone to think that the big mail-order houses whose encyclopaedic catalogues may be found in every farmhouse in the land must of necessity purchase their stock direct from the manufacturer in big lots or perhaps entire factory outputs at the very lowest price. Yet one of the largest of these firms in the country purchases their insecticides from a jobber who has his goods made up for him under his own label by a manufacturer in a distant state, who in turn obtains his principal raw material from a dealer nearly a thousand miles in the other direction, who obtains it from the producer back on the other side of the manufacturer's plant.

Therefore, before the material gets in the warehouse of the mail-order firm this finished product and raw material have made four separate trips over the same stretch of railroad, with the prospect of a fifth one when the ultimate consumer buys it.

Production Costs and Competition

The present status of the insecticide industry in the eyes of many manufacturers presents a very unsettled condition. Like most everything else prices of these goods have been moving downward, but so also have the necessary raw materials.

Lead arsenate has dropped from last year's price of 25c a pound at the factory in large lots to 15c.

But there is something else beside his own price which should interest the manufacturer. The price at which the consumer gets the product is sometimes the dam in the river of commerce.

Only a few weeks ago the writer coming across the Cortlandt Street ferry in New York met an acquaintance he had not seen for some time and who during the last three years had bought a farm and large orchard. In the conversation about fruit trees the friend made the statement that he knew he was not spraying enough but that he could not afford to pay the price asked for arsenate of lead.

With visions of the manufacturer's figure of 15c in mind I asked him what he had to pay and nearly fell from the ferry-boat into the Hudson when he re-

marked that the seedman from whom he bought wanted 75c a pound. This is of course an exceptional case but illustrates the point. The price of 15c is claimed by many factories to be close to the cost of production. The present cost of the raw materials entering into one pound of dry arsenate of lead is between 7 and 8c.

For many years there has been little uniformity in prices quoted by various makers and fierce competition often has taken place. A price war is always aided and abetted in this line by the practice of quoting a base price per pound on the largest-sized package and then increasing the price per pound as the size of package decreases, but by a hit-or-miss method which bears no relationship to proportionate size or exact additional packing cost.

In an effort to stabilize conditions in this industry a few years ago a majority of the firms joined the Armstrong Bureau of Related Industries through which agency statistical information as to sales of each participant was distributed. But these methods, humorously known in the trade as the "strong-arm methods," failed to halt what was felt as ruinous competition.

Careful investigation by the writer has convinced him that this cut-price war has not been made with any definite attempt to drive competitors out of business, but has been carried to extremes by first one manufacturer and then another who really did not know how much it cost him to produce a pound of goods.

Cost figures in the chemical industry often are hard to determine accurately by one inexperienced. The distribution of overhead with this business of seasonal operations and varied products can lead to considerable error if not carefully done.

Firms more than once unknowingly have sold their product for less than cost. This sort of thing has been happening in nearly every line of business to such an extent that the U. S. Department of Commerce has taken up the matter and has emphasized to manufacturers the tremendous importance of exact cost figures.

Secretary of Commerce Herbert Hoover even now is arranging to supply the chemical industry with statistics relative to supplies of raw materials and certain much-used intermediates to enable market conditions to be more readily forecasted and costs and selling prices accurately figured. With exact costs and market information available the insecticide business is going to flow to those firms with most economical and up-to-date methods of production, which is as it should be.

As a whole the insecticide business appears to be marking time waiting for something to happen, but, as Thomas Edison has so well said, "The firm that does not now study the rapid adoption of more automatic machinery in both office and factory will find itself unable to compete in the world's markets." And note that this applies to office as well as to factory. All too often an increase in factory output merely results in added statistical burden on the office.

In one of our largest corporations it has been estimated that the clerical work connected with every order amounts to \$1.50. Of this, 50c is the cost of getting the order from the original customer's letter through the general offices to the factory. The balance was for factory office work on the order and book-keeping.

The margin between cost and selling price in the insecticide business for the next few years is not going to allow this kind of expense, neither will it

allow of one-half of a percent loss in material through leaky and sloppy filter-pressing, or 1 per cent. loss through dusting and spilling and inaccuracy in packing, or a nitric fume loss of 7-15 per cent in arsenic acid plants, or the tremendous loss caused by uncontrolled moisture-content of materials sold in paste form.

Summary

At the present time the principal insecticides used as stomach poisons are arsenates of lead and calcium. Contact insecticides are tobacco extracts and lime-sulphur solution.

The use of a valuable material like lead tied up as the inert end of an insecticide has appeared like a wasteful procedure to some chemists. Efforts to utilize a cheaper material like calcium have resulted in a product that is not quite so safe to use on tender foliage.

Tobacco extracts serve admirably for certain uses but are soluble and easily washed-off by rains and are very expensive.

Lime-sulphur solution can be safely used only when the trees are dormant. It contains nearly 70 per cent. water and cannot be economically shipped long distances. The so-called dry lime sulphur decomposes rapidly when stored exposed to air.

In addition to these facts it has been claimed by some that the continued use of arsenical poisons over the same ground would result ultimately in an accumulation which will finally injure the roots of plants and affect their growth.

Although these claims have not been well-substantiated in regard to our present well-prepared and insoluble arsenicals it has hastened the search for other forms of insecticides.

The Ideal Insecticide

It would appear that the ideal insecticide should be poisonous to a majority of injurious insects. It should kill both as a stomach poison and by contact. It should not injure tender foliage no matter what time of year applied. It should not readily wash off by rains. It should be easy to apply without disagreeable effect to the operator. It should be cheap in comparison with its killing power and finally it should decompose through the effects of air, rain and soil so as eventually to lose its poisonous properties.

It is probable that any new discovery fulfilling the above requirements will be in the nature of an organic chemical compound rather than the metallic salts now employed.

That the Department of Agriculture realizes the possibilities of such a product is shown by their recent transference of certain chemists to undertake research work looking toward the discovery of some such organic material.

Still Plugging Along

The insecticide industry is firmly established. It is producing articles which are not luxuries but actual necessities to the modern farmer and fruit grower. None of the manufacturers have yet made marvelous fortunes, but so far as the writer knows and he is pretty familiar with the industry from its beginnings, there has never been a firm that started the production of agricultural insecticides in real earnest, that ever has quit.

There have been a few consolidations and a few outright sales but it is a remarkable fact that practically every firm that has started the business is still in the game. What other industry of the size can point to such a record?

Present Conditions and Future of the German Chemical Industry

THE German dyestuffs industry is a closely-woven group of manufactures which has at its disposal vast resources in capital, cash equipment, and personnel, and which has extended its field of activities until it embraces almost every branch of the chemical industry. In certain branches it possesses, at the moment, almost a world monopoly. It is able very largely to carry on its manufacturing operations with raw materials obtained entirely from German sources, and consequently it reaps the very fullest advantage of the rate of exchange when developing an export trade.

On the other hand, there is a shortage of certain essential materials. The cost of production has increased, the remuneration of labor being much higher in comparison with the pre-war period. The labor employed, moreover, presents some entirely new problems of management.

Changed Conditions

The provisions of the Peace Treaty prevent the Germans from controlling completely the distribution of their output. Their overseas organizations have been almost entirely destroyed as the result of the war, and in Great Britain they are prevented, at the moment, from re-establishing these organizations with their own nationals or capital. Their factories abroad have passed out of their possession.

Legislation has largely destroyed the protection they enjoyed from the manipulation of patents. The importation of their products is prohibited, except under license, in all the important countries arrayed against them in the war, and in most of these countries the competition of new national dyestuff industries has to be encountered. Such, briefly, is the position.

The German Plans

It is an obvious truism that the Germans will strain every nerve to secure again the position in the world which they occupied before the war. The period since the Armistice, however, is so short, and includes such a long interval of bad trade, that it is impossible to judge exactly in which direction the German industry has exerted its maximum pressure and secured its maximum impetus toward a condition of complete recovery and re-establishment of pre-war conditions.

If the German chemical industry existed as in 1914 it is obvious that all efforts would be made to win again the dyestuffs monopoly of the world. The basis of the industry, has, however, been greatly widened, and it would seem that the centre of gravity of the organization has moved, if not completely from the organic to the inorganic side, at least towards the inorganic side.

Increased Attention to Inorganic Chemistry

It seems that it is the inorganic side to which most attention has been paid since the Armistice, from the point of view of development and appropriation of capital, and it may be anticipated that this development will proceed until an inorganic industry of colossal dimensions has been established.

The organic field, however, has not been neglected. It is to be expected that the Germans will make use of all their pre-war experience in the dyestuffs industry, and signs are not wanting, in many of the most important markets of the world, that deliberately aggressive tactics are being employed for the purpose of

strangling competition and of re-establishing monopoly.

It is important to notice that this capacity to strangle does not arise from technical superiority or better powers of organization, but simply and solely from the ability of the Germans to adjust prices in any of the currencies of the world at a level which is below the economic level of any other industry in the world. In short, the German exchange is the German dyestuffs industry's best friend.

Probable Course of Action

The German course of action seems clear. They will first attack those markets which are wide open to them—unfortunately there are many such, including British India—and by a deliberate policy of price cutting, which their present exchange enables them to carry out without loss to themselves, will definitely re-establish their monopoly.

The cards are all in their hands for this part of the game. In those countries where legislation and natural sentiment are against them, more subtle methods must be adopted. They may attempt to insinuate themselves by arrangements with domestic manufacturers, as appears to be the case in France.

They may manipulate their prices and the distribution of their specialties so as to increase the demand for their products to such an extent as to render the restriction of imports an impossibility. They can exercise much cunning and ingenuity in evading restrictions. In this part of the game some but not all the cards are in their favor.

Statesmanship Demanded to Meet the German Menace

In spite, therefore, of many adverse factors it seems the chances at the moment favor the Germans more than others. The problem ceases, therefore, to be one of economics and becomes one of statesmanship.

A country without an organic chemical industry is as defenseless as one with its navy at the bottom of the sea and its men completely ignorant of military affairs.

A danger to a national chemical industry is as much a State question as a danger to an army or navy.

Nations such as the British, the French, and American, with world-wide responsibilities, which have been forced into war in the past and may be forced into war again, dare not allow themselves to be weakened by the destruction of their fundamental war-time industry for the glory and financial benefit of a German organization which, according to the irrefutable evidence of official history, was the backbone of Germany's military effort in the recent conflict.

President Harding has sent a communication to the Senate which has been referred to the Committee on Appropriations, asking for \$7,000 to continue the work of the dye and chemical section of the Customs Service of the Treasury Department. The greater portion of this amount is required to meet the pay rolls, and the balance for the payment of traveling expenses necessary in making investigations. The Dye and Chemical Section of the Division of Customs of the Treasury Department is the continuation of the powers and duties of the War Trade Board of the State Department.

Relation of University Chemical Departments to Chemical Industry

By Benjamin F. Lovelace, Ph.D.

Associate Professor of Chemistry, Johns Hopkins University

AN active discussion has been going on for several years having to do with the general subject of the relation of the universities to the community. The particular part of this discussion with which we are concerned is that pertaining to the relation of the departments of chemistry in the university to the chemical industries.*

However much some of us may be inclined to cling to our ideals, I think most of us will agree that the idea long held of the university as a seat of learning for learning's sake is gradually giving place to a new conception of the university as a utilitarian institution. To appreciate the change that has already taken place one need only visit the class rooms of any large institution and see the handful of students taking Greek, for example, while in any subject having a direct practical utility, huge lecture rooms are filled to overflowing.

The Needs of Life Shape the University Ideals

Many colleges and universities have endeavored to uphold the old ideals and have continued to maintain the old chairs, and a few students continue to take these so-called cultural courses and always will so long as they are offered, but it remains true that the great majority of the students are interested mainly in those subjects which have a definite practical value. This is true of both graduate and undergraduate schools. And of necessity the departments dealing with subjects which are of practical value to the student in and after life are receiving relatively greater, and increasingly greater, financial support from governing boards.

Thus our higher institutions of learning, and particularly the graduate departments, are apparently tending to become in fact professional schools; that is, institutions in which men and women receive specialized training which fits them for a particular kind of work. This development is perhaps not so much the result of the adoption of a definite policy by those in charge of such institutions, but rather comes from the demand on the part of the students themselves. The students want such courses and, if a particular university will not give them, they will go elsewhere.

The very great popularity of chemistry in the colleges and universities throughout the country is not due to a widespread scholarly interest in the science itself, but arises from the facts that chemistry is fundamentally related to the welfare of the community and that a thorough knowledge of the subject opens the door to an attractive profession.

Advanced Students of Chemistry Classified

Most of the graduate students in chemistry in the universities may be grouped under three heads:

I. Those looking forward to professorships of chemistry in colleges, in which their chief work will be the teaching of chemistry to undergraduates, with limited opportunities for research.

II. Those looking forward to careers of research in pure chemistry, either in universities or other research institutions.

III. Those expecting to become industrial chemists.

So long as the university had to do mainly with stu-

dents of the first two groups, there was no particular difficulty in providing suitable instruction for them without in any way endangering the ideals of the university laboratory as a place set apart from commercial considerations and devoted, with singleness of eye, to the cause of the advancement of science for the common good.

The course of instruction generally adopted by American universities required for its completion three or more years' work subsequent to the bachelor's degree. A part of his time was devoted by the student to acquiring a knowledge of the fundamental facts and principles of the science, after which he was required to spend one or more years in actual research under guidance.

The rapid increase in the number of students falling under Group III, that is, those who come to the university with the idea of going into industry, raises a number of problems of vital importance to the universities and to the industries themselves.

The Expanding Field for Chemists

Unless all signs fail, the demand for chemists for the industries is not a temporary one, but will continue and in all probability increase. The country has definitely set out to develop its chemical industries, the goal sought being nothing less than chemical independence. The realization, even if it is not altogether complete, or falls short of our present hopes, will call for a continuous supply of chemists.

The enhanced popular interest in chemistry also may be expected to produce an increased demand for chemists in college and university positions. It seems certain therefore that the graduate departments of chemistry (and undergraduate as well), already in many cases among the largest in their respective institutions, must look forward to a considerable increase in the number of students applying for instruction each year. This will entail problems of enlargement of buildings and other additions to material equipment, increase of teaching personnel, possible additions of new courses, etc. But these are questions which mainly concern boards of trustees and I will not discuss them here.

Character of Advanced Chemical Instruction

A group of problems are presented having to do with the content of the courses offered for graduate students. The graduate courses that have been given in the past were developed along broad theoretical lines without particular reference to the training of men for the industrial field. The attempt was made to give the student as broad an acquaintance as possible with the basic facts and principles of the science of chemistry and in addition a knowledge and experience of the methods of research.

Now, inasmuch as the industries are dependent upon the universities for the training of the chemists which they require each year in increasing numbers, it is only natural that they should concern themselves with the character of instruction given. And inasmuch as one of the functions of the university is to train men for the industrial field it is only proper that those charged with the responsibility of this training should inquire whether or not the students are receiving the kind of instruction and experience that best fits them for their future work.

*From the address as vice-president and chairman of Section C of the American Association for the Advancement of Science, Chicago, 1920.

The question therefore whether the chemical departments of the universities are giving the best kind of training to those who are to go into industrial work is entirely proper and the correct answer is of vital importance to the university, to the science of chemistry and to chemical industry.

Some Criticisms Answered

Now there are a number of people among both teachers and employers of chemists who believe that the present methods of university instruction could materially be changed to advantage so far as the future work of the industrial chemist and chemical industry is concerned and various suggestions have been put forward, most of them with the idea of making the work more "practical" in character.

It is said that the present method and scope of university teaching make the Ph.D. graduate too theoretical and impractical; that when he goes into the plant he is at a loss because he has learned to think only in terms of small scale reactions and because he has no knowledge of engineering and therefore no appreciation of the mechanical difficulties that always appear when you go from the laboratory to large scale production.

Hence it is concluded that the kind of chemist the industries need is one who is also an engineer. Hence the growth of a large number of institutions in the country in which a high school graduate is put through a training embracing four or five years, taking various courses in mathematics, physics, engineering and chemistry, is given a bachelor's degree and sent into the industry. However valuable in a chemical plant men of this training may be, their outlook upon chemistry as a whole is entirely too limited to make them of any great value in the research laboratory.

If our country is to realize its dream of chemical independence, our industries must have available and must employ large numbers of chemists of the highest quality, characterized by breadth of chemical training, familiarity with chemical literature, enthusiasm for research and, above all, a thorough understanding of theoretical principles, which alone gives the investigator the ability to interpret observations and devise sound and effective methods of attack.

The above qualities are essential to the research chemist, regardless of whether he is in an industrial or a university laboratory. For in the development of an industrial process, the first stage is in the laboratory and here the problem differs from a problem in "pure" research only in one particular, viz., that it is directed toward a definite commercial object. The same thoroughness should be sought, the same methods employed and precisely the same qualities on the part of the investigator are necessary.

Training in Fundamentals Paramount

Those of us therefore who are charged with the responsibility of university instruction in graduate chemistry should set our faces against the tendency in evidence around us to place the emphasis in teaching upon the practical, necessarily at the expense of the fundamentals.

This attitude does not in any sense mean that university laboratories should avoid attacking problems the solution of which is of importance to industry. On the contrary, one of the happy developments of the past few years has grown out of the opportunity which has been afforded to large numbers of university professors to get in close contact with some of the problems of commercial chemistry. Many of these problems, of fundamental and far-reaching importance to

the industries, have been taken into the university laboratory and the professor brings to their study his ripe knowledge and experience, his patience and resourcefulness which, combined with the material facilities at his command, offer the promise of sure progress in their solution.

Already substantial contributions along a number of lines have been made and we may confidently look forward to greater achievements in the future. The universities very properly may take advantage of the opportunities thus presented to render a high service to the community. But there are also dangers inherent in the situation.

While rendering this service, we must sedulously avoid sacrificing the ideals of pure science. We must keep out of our university laboratories the spirit of commercialism and not allow our interest in these problems of applied chemistry to lessen our interest in the large number of even more fundamental questions which happen to be of less immediate practical importance.

Service of the University Laboratory to Industry

In the foregoing discussion we have anticipated partly the answer to a question which has been discussed frequently in recent years. I refer to the matter of co-operation between the universities and the industries. How can the university laboratory render the most valuable service to chemical industry? How can industry co-operate with the university to the end that the interests of both may be best served?

It must be clear that these interests are mutual; more particularly, that any plan which enables the university more effectively to perform its function of advancing scientific knowledge and training chemists will be beneficial to industry and anything which interferes with or in any way hampers the university laboratory in the performance of these primary functions must ultimately be harmful to industry.

Recognizing the importance of this question and fully conscious of the wisdom of guiding properly the movement already under way looking toward a closer relation between the universities and the industries, the American Chemical Society, under the recent presidency of Dr. Stieglitz, authorized the appointment of a committee to study and report upon the subject. The committee consists of leading educators and representatives of industry and I believe is still engaged in studying the question in the effort to formulate a plan by which the desired ends may be accomplished without injury to the university.

Thorough and Broad Training in the Principles of Chemistry

The opening paragraph of a tentative report made by the committee reads as follows:

The most important contribution which the universities can make to the development of industry in this country is to supply the industries with sufficient numbers of men thoroughly and broadly trained in the principles of chemistry. All other considerations must be subservient to this fundamental purpose.

This is a thoroughly sound principle and if it is accepted fully and made a guiding policy by both the university faculties and the industries it will constitute a touchstone by means of which the quality of any specific proposal may be tested.

It must be clearly understood that if men are to be "thoroughly and broadly trained in the principles of chemistry" emphasis must be laid upon a good many things of which we can not at present point out any very direct practical application to industry. The fact is, however, that the number of these abstract questions

emphasized by university teachers that have no bearing upon the problems of commercial chemistry is not nearly so large as the practical man believes. In other words, chemical industry lags considerably behind chemical science.

Slow Response of the Art to the Attainments of the Science

The discovery on the part of industry that it has not been utilizing the chemical knowledge which has been available all along, carefully recorded in the literature, is really one of the outstanding events of the last five years. This is the explanation of the greatly increased demand for trained chemists. Their chief efforts will be directed, not so much toward original research, but rather toward applying what is really recorded to the practical problems of the plant.

The second paragraph of the report deals with "the strong tendency at the present to draw men, who have been particularly effective in research work, away from the universities by the payment of salaries far in excess of the salaries paid the same men in a university."

In view of the considerable number of younger men of great promise who have in consequence been induced to abandon their university careers, the report goes on to say that "it seems evident that unless a very considerable increase in the salaries of teachers of chemistry can be secured, the next generation of chemists is likely to be trained by a set of mediocre men. Such a result would be disastrous to our industries and every possible effort should be made to meet this danger."

As to the various specific proposals for co-operation that have been put forward they should all be tested by the touchstone mentioned, and if this is conscientiously done it seems to me that no very great difficulty will be experienced in reaching wise decisions.

Composition of Industrial Fuel Gases

THE composition of industrial gases, their combustible mixtures, and products of combustion, are essential factors governing the selection of gases and suitable equipment for the production and application of heat, power or light.

When a gas is to be used as a reducing agent or for some special purpose not requiring combustion, the composition of the gas itself is generally all that need be considered. When employed as a source of heat energy, however, it is necessary to consider many other factors, with particular reference to the influence of the composition of the gas or its combustible mixture upon the nature of the operation to be conducted and the design of apparatus to be employed for the generation and application of heat.*

When the material difference in B.t.u. value of the common industrial gases is considered together with the comparatively slight difference in heating value of their combustible mixtures, it is apparent that chemical composition is of greater importance than B.t.u. value in determining their field of usefulness.

The quantity of inerts or incombustibles is relatively small in the majority of industrial gases, with the exception of producer gas, of which over 60 per cent. is inert matter. The inert content is important in so far as it relates to the increase in volume of gas or combustible mixture necessary to furnish a given amount of heat energy, and to the nature and cost of equipment and operations necessary for manufacture and distribution; but it is apparent from comparison of the inert

Industrial Fellowships

There would seem to be no possible objection to the endowment of fellowships in the universities, similar to the du Pont fellowships, which leave the student and the instructor entirely free in the choice of the subject of research and which carry no restrictions in the matter of publication of the results.

Fellowships designed to promote the solution of problems for the benefit of a particular industry, it seems to me, may be safely accepted by the university, but it should be clearly understood: (1) That the subject of investigation should be of fundamental importance to the industry as a whole; (2) that the instructor and student must be left entirely free in deciding upon the method and scope of the investigation; (3) that there must be no secrecy attached to the work; and (4) that the results should be published for the benefit of the industry as a whole within a reasonable time.

It seems to me that other kinds of fellowships proposed, of a private character, for example, a fellowship endowed by a single firm for its exclusive use, either for a limited or indefinite period, would be attended with grave dangers to the university. Aside from other considerations of equally vital importance, one of the most invaluable and inspiring features of the university research laboratory, viz., the entire freedom from restrictions which prevails, would be lost by the introduction of a system of private fellowships. Each worker, while he is interested mainly in his own particular subject, needs the inspiration which comes from contact with his fellow workers, and to deny him the privilege of learning what those around him are doing is to take from him a thing of inestimable value and for which there is no substitute.

content of the combustible mixtures of the different gases that the heating value of the gases is determined more by the elements forming the combustibles than by the percentage of inerts in the gases or in their combustible mixtures.

In the generation and application of heat, we are concerned more with the heating value and composition of the combustible mixture than with the gas itself. The relative importance of chemical composition, with reference to both the character of the heat released and the chemical influence of the products of combustion upon the products to be heated or heating apparatus, is not generally appreciated. The striking changes resulting from the mixture of gas and the air necessary for combustion, the further changes following ignition and combustion, and the influence of excess air, are illustrated by the accompanying chart.

Consideration of the comparatively large volume of products of combustion of each gas, which are heated to the maximum temperature of the heating process, will indicate the economies attainable through efficient utilization of the spent gases to perform useful work. The heat in these gases may be utilized to preheat the air or fuel prior to combustion, or, as is generally more desirable, to preheat the material before it is exposed to the final working temperature.

The waste gases may be considered as a vehicle for conveying heat in the manner that a wire is employed in conveying electricity. So-called quiescent atmospheres do not actually exist. The advantages that result from the transfer of heat by convection, and the natural motion of hot gases created by a temperature differen-

*From "Selection of Fuels," by W. S. Fawcett, Ch. 51 Church St. New York.

tial, regardless of the source or manner of heat generation, indicate the possibility of utilizing an apparent disadvantage in composition, not only for effecting econ-

fact must be considered in the operation of electric as well as fuel-fired furnaces.

The field of usefulness of any gas is not entirely dependent upon the B.t.u. value or composition of the combustible mixture or products of combustion. The method of releasing heat exerts no small influence upon the result, and necessitates consideration of the physical conditions governing the design of mixers, combustion chambers, energy input, temperature, time and other factors which are not apparent in the gas itself. The comparatively high calorific intensity of water gas makes it unsuited to certain forms of equipment which may be employed to advantage with other gases such as natural gas, city gas or producer gas.

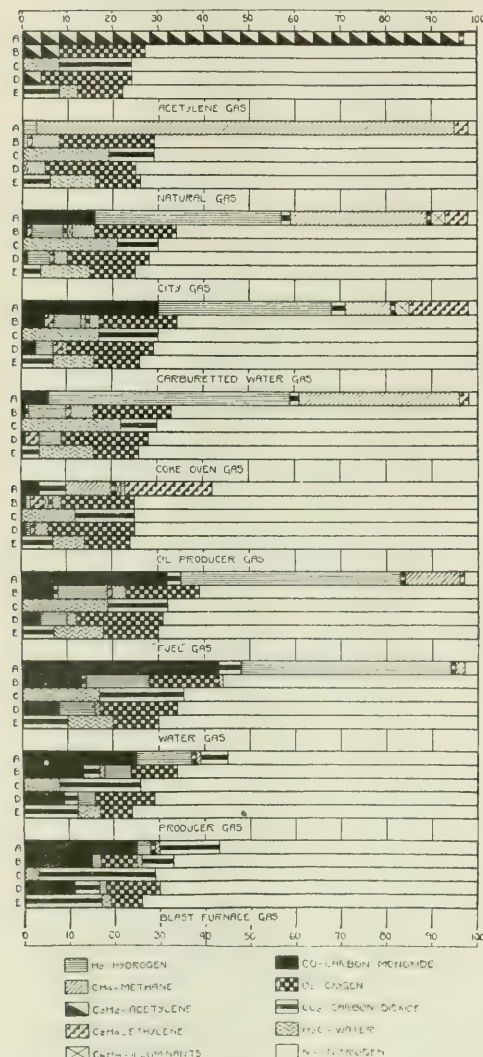
The composition of the products of combustion must be considered in relation to its influence upon the product, because furnace atmosphere plays an important part in some processes which may require either reducing, neutral or oxidizing conditions. Frequently the apparent advantages of a comparatively cheap fuel may be offset by the chemical action of the resultant gases upon the process or apparatus, which would necessitate modifications in the furnace design or process in order to retain the advantage that may be represented by the form or price of such fuel. This is illustrated by the practices of employing crucibles for melting certain metals to decrease the possible effect of oxidation; of packing material in sealed boxes or pots; and by the muffle type of furnace employed for vitreous enameling; in each case permitting the application of heat without contact between the material to be heated and the products of combustion. Special atmospheres may be secured in muffles by passing suitable gases into the muffle, which may or may not be sealed.

Such limitation is not confined to fuels alone, as it is frequently encountered in the arc or resistance methods of releasing heat from electricity due to the gasification of the electrodes or resistance material. In most cases it is desirable to maintain neutral or reducing atmosphere in the heating zone to protect the material from oxidation. While this may be readily accomplished with most fuels in properly designed furnaces by control of the air supplied for combustion, it is comparatively difficult with others. Such a neutral or reducing atmosphere may be readily secured in electric furnaces releasing heat through some form of carbonaceous resistance material, while a different form of resistance material may necessitate the use of a material such as oil to provide the proper atmosphere in the heating zone, even though the heat itself is generated by an electrical process.

The gases, such as coal gas, carburetted water gas, etc., commonly known as "city gas" of about 600 B.t.u., have a lower flame temperature than unmixed water gas of about 300 B.t.u., although the B.t.u. values of the combustible mixtures are approximately the same. The difference in chemical composition of the gases themselves, resulting in an apparently insignificant difference in odor, makes the so-called "city gas" preferable for general distribution to domestic consumers. The use of unmixed water gas for this purpose is prohibited by law in certain sections on account of the difficulty of detecting leakage, although its use may be permitted in industrial plants where the danger due to lack of pronounced odor is less.

The fundamental significance of chemical composition as affecting the quality and cost of product, must be considered in the selection of gases and of equipment for the transformation and application of their energy values.

A=VOLUMETRIC COMPOSITION OF GAS
B=COMBUSTIBLE MIXTURE THEORETICAL AIR SUPPLY
C=PRODUCTS OF COMBUSTION THEORETICAL AIR SUPPLY
D=COMBUSTIBLE MIXTURE 100% EXCESS AIR
E=PRODUCTS OF COMBUSTION 100% EXCESS AIR



COMPARISON OF INDUSTRIAL GASES

Volumetric Composition of Gas, Combustible Mixture and Products of Combustion

omy in fuel but for improvement in methods of heat application.

The efficiency of such utilization is dependent upon the design of the furnace or other appliance, and particularly the manner of heat application and manner of handling the material and exposing it to the heat. This

Work of the Chemist in Margarin Manufacture

By H. P. Trevithick

Chief Chemist, Bureau of Chemistry, New York Produce Exchange, New York City.

IN 1869 the French Government offered a prize to the chemist who would devise the best economical substitute for butter for the use of the armies of Napoleon 3rd. The prize was won within the next year by Monsieur Mege-Mouries, who followed the most obvious lead and turned toward beef-fat as a probable source of the needed product.*

By careful chemical and physical research this chemist discovered that he could take the choice portions of beef fat, such as the caul and ruffle fat, and by chilling, graining and pressing the fat obtain a sweet, light-yellow, buttery fat, which he called oleomargarin and which is known in this country as oleo oil. By emulsifying this fat with naturally soured skim milk Mege-Mouries produced the first commercial margarin.

Thus we see a chemist as the founder of the oleomargarin industry, and, as the industry has grown, it has been supplied constantly with new raw materials, and the quality of the product has been improved through the effort of the chemist. Metchnikoff, a Bulgarian chemist and bacteriologist, working in Paris, isolated the bacillus which causes the souring of milk and thus laid the foundation for the margarin manufacturer's use of pure cultures to obtain a suitable flavor in his product.

The vegetable oil industry in this country is of recent origin, and, of course, the chemist's connection with it has developed only within the last two or three decades.

While I was in the South connected with a crude cotton oil mill stories were still current of the good old days when there were no chemists to worry the managers and superintendents and the mills left 15% or more oil in their cake and mills made 100% on their capital invested in a year.

Before the cotton-oil mills started, the seed was a waste product which not only was of no value but was causing serious damage and its disposal was a most troublesome and expensive problem. Gin operators hired men to remove the seed from the dumps around the plant. If the seed was thrown into the creeks it would choke them, and whether on the land or in the bayous, it would rot and emit a horrible odor. Hence state laws were passed regarding the disposition of the seed, and many lawsuits were caused. In quite frequent cases, the gins, after all the space around them was filled with rotten seed, were moved bodily to another location, it being easier to move the gin than the seed.

An oil miller would go out to a plantation, look at a pile of seed, containing possibly 100 tons or 200 tons and offer \$150 for the pile. The result was that a

mill costing \$30,000 to erect, made \$100,000 in a single season.

Now, as a result of the chemist's work in finding new methods of using the oil and new methods of pressing and handling, the oil mill makes far more oil per ton, and the price of the seed in normal times is about \$30 a ton. During the war it reached \$80 or more a ton.



H. P. TREVITHICK

Chief Chemist, Bureau of Chemistry,
New York Produce Exchange

The Work of Wesson

Margarin manufacture is a more recent development of the oil industry and is a development which is wholly due to the pioneer work of such chemists as Wesson, and others, in showing how to refine vegetable oils so as to make them suitable for the best grades of margarin.

By taking the best grades of oil made, using first the cottonseed, and then gradually turning to the peanut and coconut oils, and stiffening them with oleo oil, lard, and lard stearine, fairly good butter was made. Under the leadership of the same chemists, vegetable stearine pressed from cotton oil was substituted for animal fats, and finally hydrogenated cotton, peanut and coconut oil were used, giving a pure vegetable compound, the true nut margarin. By churning this product with milk the chemist is able to make a product which compares very favorably with the best dairy butter in flavor and digestibility, and which is

considered a much cleaner and a more sanitary product.

Inspection of Raw Materials

In manufacturing a margarin the chemist must exercise scrupulous care in inspecting his raw materials. He must see that the oil, whether purchased or refined in the plant, is absolutely sweet, free from free fatty acids and in no danger of going rancid. If the oil is refined in the plant the absolute removal of soap from the refined oil must be accomplished before bleaching and deodorizing the product. This point is not watched closely enough in many plants and results in poor oil. An oil with an increased acidity as it leaves the deodorizer probably showed that same or greater increase as when it left the bleaching kettle. This fact has been noticed in numerous cases and is due apparently to the breakdown of slight quantities of soap left in the oil after refining, the caustic being removed by the clay and the acids being liberated to damage the oil. As careful treatment of the oil to remove the soap-stock before bleaching will remove this difficulty, there can be no question of the fact that the soap is left in the oil, and dissociated in the bleaching kettle, although many refiners blame the increased acidity on the deodorizer.

Of course, on purchased oils the inspecting chemist must be guided by the flavor in detecting improperly

*Presented at Atlantic City meeting, June 30, of the Institute of Margarin Manufacturers.

finished oils. The oil should be purchased subject to approval of sample, and the sample should be filed with some commercial oil chemist who would see that the delivery equaled the sample. Shippers also would be better protected if samples of their parcels were approved before shipping. In one case, 2,000 barrels of deodorized coconut oil were shipped 1,500 miles to New York, and destined to Europe. On inspection at New York, the lot was rejected because of flavor and high acidity. The shipper was compelled to return the material to his plant, to wash the oil to remove the excess acids, and then sell it as refined oil, losing the double freight and handling charges in addition to the cost of treating the oil again after emptying the barrels, and his losses due to selling a deodorized oil as a refined oil.

A further difficulty with the shipment of barreled oil seems to be caused by hot weather in the summer. A winter cottonseed oil is an oil which has been chilled below freezing and pressed at a low temperature to remove the stearine. A prime winter oil must be absolutely clear after standing five hours at a temperature of freezing. After having tested numerous samples of shipments of such oil, both at plants before barreling and after being in the barrels various periods of time, it was noticed that almost all winter shipments of such oil were satisfactory, the failures being due to faulty, careless or indifferent work in the refinery. However, nearly all the shipments made in summer were unsatisfactory, although the shipments were made by many reputable refiners located in various parts of the country. By testing the oils before barreling, it was proved that they were good winter oils. Further tests showed that the material causing the cloud was moisture and soap. As the oils were barreled when perfectly free from these and the barrels were absolutely dry, it was shown conclusively that the fault was the action of the sun's heat on the barrels, causing a reaction between the slight free fatty acids of the oil and the free caustic of the silicate, with which the barrels were lined. This action seems to occur whether the oil is left exposed on the loading platforms, or yards, to the direct rays of the sun, or whether it is loaded in box cars immediately after barreling. The length of time necessary for the reaction to occur seems to depend, however, on the exposure to the sun's heat. This can happen not only in cotton oil, but can and does happen with coconut oil frequently, this accounting in some instances for the presence of soap and moisture in coconut oil as received at the margarin plant. The chemists' rejection of such oil will cause the refiners to exercise more care in the silicating of their barrels and filling of same with oil.

As with the oil, the chemist should inspect the milk received by the margarin plant, testing it for acidity, total solids, and fat, and also the salt, determining its purity, solubility and fineness.

Such information, which the chemist easily can furnish, regarding all raw materials purchased or offered for purchase is of the greatest value in determining their desirability or lack thereof, for margarin manufacture.

Factory Control and Waste Elimination

The compounding of margarin is an operation governed entirely by the laws of chemistry, including inorganic, organic, physiological and physical chemistry, and bacteriology. Considering first the preparation of the milk, whether it is ripened with or without the addition of a pure culture of lactic acid bacteria, the

proper degree of acidity will be determined by chemical measurement, rather than by the old-fashioned method of taste, which can vary widely with the personality and physical condition of the taster (or what he had for breakfast). The chemist should determine also the best time and temperature of pasteurization and cooling for the results desired. Having established these standards he should require faithful adherence to them in the handling of every batch.

Making and cooling the emulsion is a mechanical operation entirely dependent upon well-established laws of physical chemistry. For uniformity of results, the temperatures of the various ingredients when mixed, the time and speed of agitation, the temperature of the cooling medium, the rate of cooling, the temperature of the cooled material, should all be established by the chemist and adhered to for every batch.

In ripening the goods, the temperature of the room, the temperature of the goods, the time of ripening, the acidity before and after ripening, agitation if needed, and the amount are all important. The chemist should know all of these for each class of goods and why each figure should be what it is and not something different.

Also in the working, the temperature of the room and of the goods, the percentage of salt for best results, the percentage of moisture and milk solids before and after working, will all be of value in standardizing processes and products.

In these days of enforced economy the question of reducing losses and wastes in factories is a vital one, and here is where the chemist should shine. In melting oil out of barrels do you get it all and nothing else, or are your methods wrong? Have the chemist prove the absence of silicate and soap and insoluble matter by analysis, not by saying, "Well, we got out the marked weight." Do you get the overrun you should with the amount of milk and salt used? Analysis of plant effluents may show an appreciable amount of oils or milk solids or both, going down the sewer. Will the amount possible of recovery by various means pay the interest on the investment necessary? The chemist can provide this information.

If all the above control-methods have been enforced and adhered to, the products should be clean, economical, tasteful, healthy, and above all, uniform, but still the chemist should test every lot of finished goods for moisture, milk solids, salt and acidity, just to see whether what ought to be really is.

Maintenance of Quality—Invitation to Research

We constantly are seeing the introduction of new oils and oil products, animal and vegetable, hydrogenated and plain, so that the margarin manufacturers' chemist should devote what time he has for research to experimenting with new combinations as bases for margarin, keeping ever before him the ideal of the nearest possible approach to the physical and chemical characteristics of butter at the lowest cost compatible with quality. Then in "spare" moments, the chemist should chase a few vitamins. He may find them in margarin yet. Some other fellows say they are in some other things. They know they are there. Because they can't find them they claim they are not in margarin, for the same reason. How can we know they are not in margarin until we find some there?

It is necessary not only to employ earnest, experienced, honest chemists, but to give them tools and apparatus to work with, to have confidence in their judgment in chemical and physical matters, a thing which

can be done if good chemists are employed. The employer should inspire them with the spirit of accomplishment and the joy of good work well done, and above all remember that the laborer is worthy of his hire, and that to get and keep a good chemist you must give him a chemist's salary.

Don't make the old American manufacturer's mistake of hiring "two young fellers yesterday, one of them the chemist, the other the office boy, and ding me if I can remember which's which."

The average American oil refiner says all the margarin manufacturers are too technical and the average margarin manufacturer says the oil refiners are all very careless. I am using the mildest terms. Those of us who have worked in both these fields of endeavor know that the object of both is the same, to make a product of the finest quality possible. I respectfully would suggest that there be adopted a code of standards of

quality for the various refined vegetable and animal oils purchased by its margarin manufacturers and each one pledge himself to demand adherence to those standards in his purchases. Disputes as to quality could then be referred to disinterested referee chemists under agreement between buyer and seller to abide by their decision.

This is the method used by the Interstate Cottonseed Crushers' Association and the New York Produce Exchange, both of which bodies already have standards covering most of the oils purchased by margarin manufacturers. It is the writer's belief that such a background for purchases would insure the receipt of raw materials of the best possible quality.

The cornerstone and keystone of the margarin industry, from the refining of the oils and preparation of the milk to the packing of the finished product, are chemistry and chemical control.

Conditions in the Fertilizer Trade

As Reflected in the Fortunes of the American Agricultural Chemical Co.

By Robert S. Bradley

Chairman, Executive Committee American Agricultural Chemical Co.

AFTER we paid our federal taxes, all charges and inventory adjustments for the fiscal year ending June 30, 1921, our company shows a deficit of \$11,158,442 on the year's business, which is an extreme oscillation of the pendulum from a surplus of \$5,281,562 for our activity of the preceding year.

The past year has been a disastrous one to many industries, to which the fertilizer business proved to be no exception. The causes for this unprecedented experience in this industry may be briefly summarized in the following statement:

Our sales for the year ended June 30, 1920, were the largest in the company's history and the demand for our products in the spring of 1920 exceeded our capacity of production. In anticipation of a still greater demand for the ensuing year, and pursuant to the usual and necessary practice in the industry, manufacturers generally had contracted for a large portion of their requirements of raw materials before the decline in prices of farm products had made much progress.

The fall trade of 1920 fulfilled our expectations up to the month of October, when a rapid decline in the prices of all farm products began, and before the opening of our spring business, which is normally much larger than our fall trade, cotton had dropped from the peak of 43 cents per pound to 12 cents, wheat from \$3 per bushel to \$1.50, potatoes from \$10 per barrel to \$1 and other crops in like proportion.

Commodity Prices Break

With the Department of Agriculture insisting on a drastic reduction in fertilizer prices and advising the farmers to withhold their orders, with farm products selling far below the cost of production, with the country banks unable to extend the usual financial assistance to the farmers, and with the fertilizer manufacturers carrying heavy inventories, the inevitable happened in the spring of 1921. The farmers delayed their purchases to the last moment, manufacturers began an indiscriminate cutting of prices, and the trade became badly demoralized over a wide area of the country. Prices crumbled and it soon became a buyers' market, with a largely restricted demand. This in short tells the story of the fertilizer business of the spring of 1921, the first instance in its history, covering a period of 65 years, in

which a general depression in trade or a financial disturbance has materially affected this industry.

The price concessions made to meet competition, the deduction of \$5,022,731 on our inventories to adjust them to market values, and the decline of about 30 per cent in our sales disclose the extent to which the above conditions affected our company's operations for the past fiscal year.

Agriculture, however, must surely recover in due time and with it the fertilizer industry—an indispensable adjunct. As Mr. Eugene Meyer, Jr., managing director of the War Finance Corporation, has recently said:

"Importance of the agricultural interest is paramount in our national economic structure. I have repeatedly said, the past few months, that manufacturers, merchants and bankers cannot pull themselves out of the hole without pulling the farmer out of the hole."

There are already encouraging signs of improvement. Our salesmen are now canvassing the trade for fall business and prices appear to be stabilized; farm labor is plentiful at reduced wages; crops planted last spring with insufficient fertilizer are showing poor results in yield and quality. These factors, combined with lower fertilizer prices, should stimulate a greater demand for our products.

Our collections have been practically normal outside of the cotton states and Cuba, which comprise about one-third of our business. With these districts included, we had, at June 30 last, collected over 81 per cent of our entire 1920 sales.

We are bringing about many changes in our organization and affecting economies in many departments, which will not only materially decrease expenses, but will at the same time increase efficiency. Factory wages have been reduced and labor efficiency equals or even exceeds pre-war standard. The management looks to the future with confidence in the revival of the fertilizer industry and in the return of prosperity to the company.

M. J. Lane succeeds C. E. Foster as manager of the Boston office of John Campbell & Co., 75 Hudson street, New York.

Improvements in the Ammonia-Soda Process

By James H. MacMahon

Technical Representative, Mathieson Alkali Works, Inc.

IN the ammonia-soda process a suitable ammoniacal brine, that is, a sodium chloride solution nearly saturated with ammonia, is subjected to the action of carbon dioxide under pressure in towers of suitable construction. The carbon dioxide for the operation is commonly manufactured by burning limestone in kilns specially constructed for the recovery of the carbon dioxide evolved. The carbon dioxide from the limestone is, however, mixed with the gases from the combustion of the fuel together with some excess air and nitrogen, so that the concentration of the carbon dioxide in the kiln gases is commonly about 30 to 36 per cent. and in practice may be as low as 25 to 28 per cent.

In using a carbonating gas containing such a relatively low percentage of carbon dioxide it is necessary to pass a large amount of the gaseous mixture through the carbonating towers in order to supply a sufficient amount of carbon dioxide, and, since the concentration of ammonia in the ammoniacal brine is fairly high, the escaping gases carry away with them a considerable amount of uncombined ammonia.

The loss of the ammonia with the escaping gases can be minimized by scrubbing the exit gases from the carbonating tower with fresh brine, but the large amount of escaping gases makes this recovery difficult. So also, in the carrying out of the carbonating process, the operation ordinarily is stopped while the reaction mixture contains an appreciable amount of free ammonia, amounting to as much as 3 per cent. or more, largely for the reason that the reaction with the carbon dioxide takes place very much more slowly as the concentration of ammonia reaches such small concentrations, and particularly where the gas employed for carbonating is itself relatively low in carbon dioxide.

According to my invention, a gas richer in carbon dioxide is produced and supplied in the carrying out of the ammonia-soda process, so that the carbonating operation can be made considerably more complete in a given time, and with reduction in the amount of free ammonia remaining, while the more rapid absorption of the carbon dioxide in an apparatus of given size, due to the increased concentration of the carbon dioxide employed, results in greatly increased production.

The use of a carbon dioxide gas of materially increased carbon dioxide content also materially decreases the total gas volume to be handled and to be passed through the absorbers and correspondingly reduces the volume of escaping gases and the loss of ammonia escaping therewith. The production of the high concentration carbon dioxide gases, according to the process here described, also is affected in an improved manner which makes unnecessary the provision of lime kilns for this purpose.

The production and utilization of the high concentration carbon dioxide gases are carried out in combination with the liquefaction and separation of air, and in combination with the manufacture and separation by liquefaction of water gas, as well as in combination with the production of synthetic ammonia. The advantages and distinguishing features of the invention will appear more fully from the following description.

Nitrogen and Hydrogen

In the practice of the invention*, atmospheric air is

subjected to liquefaction and separated into its components, nitrogen and oxygen, or into substantially pure nitrogen, and oxygen containing but a small proportion of nitrogen. The nitrogen thus produced is made use of in the synthetic production of ammonia and the resulting ammonia is supplied to the brine for the production of the ammoniacal brine of the ammonia-soda process. Water gas, produced in the usual way from coke and steam, similarly is subjected to liquefaction and separation, after suitable purification, and is thereby separated into approximately equal volumes of hydrogen and carbon monoxide. The hydrogen, after suitable purification, is supplied to the synthetic ammonia process where it is combined with the nitrogen resulting from the liquefaction of air.

The carbon monoxide is in part burned with the oxygen from the liquefaction of the air and with further amounts of air to supply the high-content carbon dioxide gases for the carbonating operation, while the excess carbon monoxide is available for use as fuel or for the production of power. The high-content carbon dioxide gases thus produced can be combined with the carbon dioxide resulting from the calcination of the sodium bicarbonate and thereby further enriched before their passage to the carbonating towers.

Procedure

The accompanying drawing illustrates in a diagrammatic manner the various reactions and steps of the process. In this diagrammatic illustration the spaces indicating the various gases are approximately proportional to the respective gas volumes.

Approximately five volumes of air, indicated at 1 are subjected to liquefaction and separation in the gas liquefying and separating machine A. The air is thus separated into approximately four volumes of nitrogen indicated at 8, and one volume of oxygen indicated at 6. It will be understood that, in practice, the air is purified preliminarily, and that some small amount of nitrogen may accompany the oxygen, but it is desirable that the nitrogen should be as free as possible from oxygen.

The liquefaction apparatus will, as usual, be arranged with the proper heat interchangers so that the power used in liquefaction is largely regained in the cooling of the incoming air. The nitrogen separated from the air is made use of in the catalytic apparatus B, in conjunction with hydrogen for the production of synthetic ammonia.

Water gas, produced from coke and steam in the usual way, is indicated at 3, the amount being 24 volumes of which approximately 12 volumes is hydrogen and 12 volumes carbon monoxide. This water gas is subjected to liquefaction and separation in the liquefying apparatus A¹. The liquefaction apparatus is operated in stages, so that moisture and carbon dioxide are first removed, together with most of the impurities, such as sulphur compounds, which if not removed would injure the catalyst in the catalytic apparatus B.

The liquefaction and separation of the water gas results in the production of approximately 12 volumes of hydrogen, indicated at 7, and 12 volumes of carbon monoxide, indicated at 4. The hydrogen, if it contains any objectionable impurities, should be further purified, and is then passed to the catalytic chamber B

*U. S. Letters Patent 1,384,141.

where it is caused to react with the nitrogen to form a synthetic ammonia, in the presence of a suitable catalyst and at an appropriate temperature and pressure.

The ammonia is separated in liquid form or by absorption in water or otherwise, and the unchanged nitrogen and hydrogen are returned again to the catalytic compartment B. The synthetic ammonia formed, theoretically amounting to 8 volumes, is indicated at 9. This ammonia is supplied to the ammonia-soda process to form the ammoniacal brine in the brine carbonating towers D, D' and D''.

Part of the carbon dioxide required in the ammonia-soda process is supplied by calcination of the sodium bicarbonate to form soda ash. For this reason it is necessary to supply only sufficient additional carbon dioxide to make up that necessary for the carbonation. This carbon dioxide is supplied by combustion of a part of the carbon monoxide obtained from the water gas, approximately 4 volumes being used for this purpose, when an equal volume is obtained from the calcination operation resulting in the production of the soda ash.

This combustion of a part of the carbon monoxide is effected with the use of the oxygen obtained from the air liquefying and separating apparatus, together with such further amounts of air as are required for the combustion. Four volumes of carbon monoxide thus will combine with one volume of oxygen and with the oxygen of five volumes of air, indicated at 2, to form approximately 8 volumes of carbon dioxide of 50 per cent. concentration indicated at 11.

The combustion of the carbon monoxide can be effected advantageously in a suitable combustion engine or apparatus such as that indicated conventionally at C, thus supplying power which is available for use in the carrying out of the process. The carbon dioxide thus obtained, and which is of high carbon dioxide content, is combined with the carbon dioxide from the calcination furnace F and is passed to the carbonating towers D, D' and D''.

From the brine carbonating towers the residual unabsorbed gas may be passed into the air at 12 but it is preferably washed free from ammonia gas by the use of a small amount of fresh brine. This gas is of high nitrogen content, usually over 90 per cent. nitrogen, and it can be used, after such further purification as may be necessary, in the manufacture of synthetic ammonia by combining it with the nitrogen coming from the liquefaction apparatus A.

Carbonating the Ammoniacal Brine

In the operation of the carbonators D, D' and D'', the ammoniacal brine may be produced from a suitable natural brine, which should be nearly free from calcium, magnesium and iron salts, and which should contain from 295-310 grams of sodium chloride per liter

The brine is nearly saturated with ammonia, usually at about 68-75° C., and the brine should contain about 60-70 grams of ammonia per liter. The volume of the original brine is somewhat increased by the introduction of the ammonia. The ammoniacal brine is cooled to about 25-30° C. before treatment with the carbon dioxide.

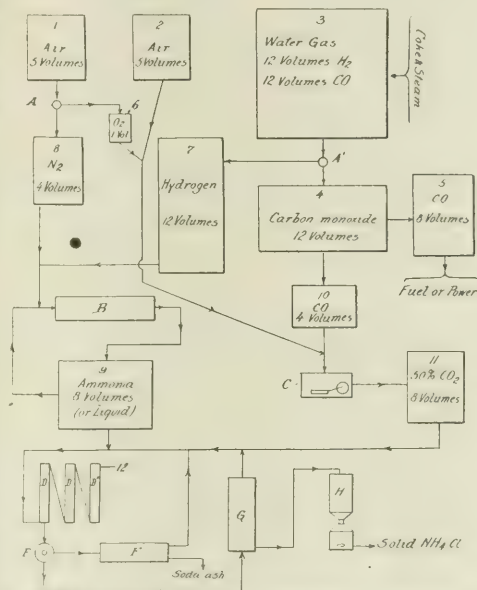
The carbon dioxide gas, produced as above described, and which is relatively rich in carbon dioxide, is pumped into the carbonating towers under pressure. The carbonating towers may be of the usual construction so that the gas will be caused to bubble through the brine from section to section of the apparatus, and thereby brought into intimate contact with it. The carbonating towers thus may be of the type employed

for scrubbing or cleaning gases, that is, tall towers constructed in sections with the gas bubbling through the brine in each section. The utilization of a carbonating gas rich in carbon dioxide has the advantages above mentioned, very materially increasing the rapidity of the reaction and the capacity of the apparatus, as well as the degree of the reaction, etc. The carbonating towers are operated at a working temperature of about 29-30° C., to give a crystalline sodium bicarbonate which is filtered easily. Lower temperatures tend to give a finer grained bicarbonate which is more difficult to filter.

Products of Carbonation

The reaction which goes on in the carbonating towers results in the production of sodium bicarbonate and ammonium chloride, the sodium bicarbonate separating out in crystalline form while the ammonium chloride remains in solution. The sodium bicarbonate can be filtered on a continuous rotary type of filter, indicated at E, then rinsed with a small quantity of water to remove contaminating ammonium chloride and excess sodium chloride. The resulting damp sodium bicarbonate then can be fed directly into the calcining apparatus F in which the soda ash is formed and carbon dioxide set free for further use in the process. Where the sodium bicarbonate is itself to form the final product, the calcination will be omitted and a correspondingly larger amount of carbon dioxide must be otherwise supplied. When the bicarbonate is to be calcined, this advantageously can be carried out in a closed rotating iron drum, so that the carbon dioxide set free may be collected and recovered from the calciners in a nearly pure state. When this carbon dioxide is combined with the 50 per cent. carbon dioxide indicated at 11 the concentration of carbon dioxide is correspondingly increased.

The aqueous solution from which the solid sodium bicarbonate has been filtered is then heated or "distilled," in the still G, in order to break up the ammonium bicarbonate and distill over the ammonia together with the slight excess of free ammonia normally pres-



Sketch of Procedure of Ammonia-Soda Manufacture in Conjunction with the Synthesis of Ammonia and with the Production and Utilization of High Percentage Carbon Dioxide Gases.

ent. This ammonia is returned to the process. The solution which now contains the ammonium chloride can be further treated, by evaporation, for the separation of the ammonium chloride therefrom, and the ammonium chloride thus recovered in a solid form.

Summary

By operating in the manner described, the burning of lime for the production of carbon dioxide is unnecessary, nor is lime required for treatment of the ammonium chloride produced by the process for the recovery of the ammonia therefrom. The ammonia is supplied in the form of synthetic ammonia, and the ammonia is obtained at the end of the process in the form of ammonium chloride, the chlorine of the brine being thus used to fix the ammonia from the synthetic ammonia process.

So also, the water gas employed, after separation by liquefaction, is made use of in the process, the hydrogen, after suitable purification, being used for making synthetic ammonia, and the carbon monoxide being used for the generation of power and for producing a part of the carbon dioxide required in the operation. The burning of part of the carbon dioxide with the oxygen separated from air by liquefaction gives a much hotter flame than with air alone, and this heat can be utilized in calcining the bicarbonate, to make a fine quality of dense soda ash, or the combustion otherwise can be taken advantage of.

A considerable amount of carbon monoxide, indicated at 5 in the drawing, is available for fuel or power purposes, thereby supplying part of the power necessary for the process, for example, in the liquefaction operation. The combustion of the carbon monoxide, with the enriched mixture of air and oxygen for the production of the carbon dioxide required in the process, can be effected in a combustion engine or under boilers or otherwise, care being taken to cool the resulting gas to about 30 degrees C. before passing it into the carbonating towers.

The utilization of a carbonating gas rich in carbon dioxide likewise results in a reduction of the power required for its compression, as well as a more rapid absorption in the brine, or equal rate of absorption with the use of lower pressures. The carbonating towers thus may be decreased in size or, for apparatus of a given size, the capacity will be materially increased.

Inasmuch as lime is not required for recovery of the ammonia, and inasmuch as carbon dioxide from the lime kilns is not required, these lime kilns are made unnecessary by this process. The ammonia is continually supplied to the process and fixed as ammonium chloride which is obtained in a solid form by evaporation. This evaporation can with advantage be effected in multiple effect evaporators followed by crystallization of the ammonium chloride from the hot concentrated solution.

Importance of Knowledge of Production Costs to Efficiency in Chemical Manufacture

By Raymond Curtis

DURING the past few years developments in the direction of more accurate and detailed records of production costs in chemical works have been rapid. While the value of such information for purposes of scientific management has long been recognized in manufacture, the ascertainment of production costs, as distinct from their value for commercial purposes, is apt to be overlooked in many chemical works. It is from this point of view, however, that the technical chemist is primarily concerned with any system of works accounts.*

In the first place it should be realized that the majority of questions relating to chemical manufacturing processes can be discussed intelligently only with a full knowledge of production costs. If this knowledge is withheld from the technical chemist—as it too often is—his usefulness is so far curtailed that in most cases he merely functions as an intelligent foreman.

Innumerable problems which demand consideration of production cost will occur to every works chemist: such problems as the extent to which an increased output might compensate for decreased percentage yield; what increased yield would justify capital outlay in improved plant; or the stage in the extraction of a product from waste material at which the cost of extraction exceeds the value of the material isolated.

Such problems as are here indicated do not, of course, occur every day, but there are daily problems incidental to efficient management—questions of yield, handling of labor, cost of repairs, consumption of steam, press-cloths, kilowatts, etc.—which for intelligent consideration demand a knowledge of monetary values. More-

over, this knowledge is of itself a very keen incentive to economy. Particularly is such information regarding costs essential at the present time. Pre-war comparative costs help us not at all, and if the chemist is to overhaul his processes in the light of these new and changing values he must have the necessary knowledge of production costs to guide him. As an instance of this one may refer to filter cloth prices. Before the war the price of filter cloth was a negligible factor in the cost of most dyestuff intermediates. But a year ago it was costing in some cases over 1d. a lb. on products the pre-war selling price of which was about 9d. a lb. Now it may be that this expenditure is necessary, but until the chemist realizes the cost involved it is unlikely that he will have explored every avenue that might lead to economies in press-cloth consumption.

Since the war system of works accounting introduced by the Factories Branch of the Department of Explosives Supply into the Government explosives factories has come in for a good deal of attention, and it is of interest to consider how far it meets the chemist's requirements.

In the first place it was the custom to record the production cost of each process separately, and not merely the final products. In some systems of cost accounting the cost of all intermediate processes is regarded as a debit against the manufacture of the final product; but this is not nearly so satisfactory a method from the chemist's point of view, since the effect of the costs and efficiencies of these subsidiary processes upon that of the final product may be obscured or lost sight of altogether.

The knowledge of production costs which was available to the technical staff monthly in the form of a cost

*Abstract of paper, Manchester Section meeting, May 6, 1921, Society of Chemical Industry.

analysis for each process showed quite clearly the cost of the various items entering into the total manufacturing cost. For the solution of some of the problems of manufacture of the type indicated above this information was of great value, and by drawing attention to the monetary equivalents of efficiencies and charges it led the chemist to make considerable economies in manufacturing costs. Moreover, all the costs from the various factories were analyzed and put on a comparative basis, so that the cost of any one product, say nitric acid at Queen's Ferry, could be compared as fairly as possible with that of Greta, Oldbury, etc.

These comparative costs, together with graphs constructed for easy comparison, were printed and issued to all the factories concerned. Besides this they formed the agenda for monthly meetings in London which were attended by chemists and engineers from the various factories. In this way each works chemist had not only the cost analysis for his own particular plant or product, but that for every similar plant under the Department; and he thus had a perspective with which to view his own achievements. Any cost item could not be considered satisfactory if it compared unfavorably with that in some other plant. Naturally such comparisons fostered a very keen rivalry between the staffs of the different factories and helped to reduce manufacturing costs.

Although it is not possible for most private firms to institute anything exactly comparable with* these comparative cost summaries (unless they have several plants making the same products), they could, with advantage, give the chemist cost analyses for plants and processes other than his own; for sufficient similarity would exist for useful comparative purposes, and a healthy rivalry for economy could be stimulated. Moreover, monthly costs meetings for the technical staff would prove to be a wonderful stimulus to efficient manufacture.

In one important respect the Government system of production cost accounting failed to meet the requirements of the chemist. If knowledge of production costs is to have its greatest value for the technical staff it should be available when the expenditure is incurred. The consideration of such information which relates to manufacturing operations carried out even two or three months ago, as in the Government factories, to say nothing of eight or nine months ago as in some factories, tends to become very perfunctory. For, generally, monthly figures require further analysis before certain items of cost can be elucidated. Sometimes the import of even serious items of expenditure has been forgotten, while the figures can afford no economizing check on day-to-day expenses, nor do they enable the chemist to check the accountant's allocations. These are such serious objections that no chemist could be satisfied with merely monthly cost analyses.

Unfortunately the chemist, while admitting the inadequacy of such records, is too apt to be satisfied with the accountant's plea that more frequent analyses are out of the question. In this connection it may be of interest to chemists to have some details of the system which was introduced in 1918 at H. M. Factory, Avonmouth.

This factory had to supply the London office with exactly the same type of information as the other Government factories, and a similar monthly analysis of manufacturing costs had to be made. In the other factories the system of works accounts with its allocation of costs was administered by the Finance sections, but at Avonmouth the superintendent set up a produc-

tion cost office to deal with the allocation of production costs and provide the necessary information required by the technical staff. The production costs office routine was so organized that the information was collected daily, and each day an analysis of the previous day's expenditure was made. This was issued to the managerial and technical staffs in the form of a daily cost sheet. There were three exactly similar sheets dealing with sulphur trioxide, ethylene, and mustard gas manufacture, the three products with which the Avonmouth factory was concerned. The expenditure* was analyzed on the same lines as in the monthly cost sheets already referred to, but much more detailed information was given. Thus under the heading *maintenance labor charges* the following subdivisions of the Grillo plant were made—burners, scrubbers, converter house, blower house, absorption house, storage tanks.

The points of interest to the chemist in connection with the Avonmouth scheme are firstly, whether it proved to be workable, and secondly, whether the results justified the expense of a daily allocation of costs. With regard to the first point, it can be said that the difficulties encountered in introducing the system were remarkably few, and the cost sheet for sulphur trioxide manufacture was issued daily during the whole of the time the oleum plant was running. The technical staff were unanimous as to its immense practical value in enabling them to effect economies in manufacture.

One has only to compare the Avonmouth manufacturing costs for sulphur trioxide with those for the other Government factories to realize this. Thus the average manufacturing cost of sulphur trioxide during the period January-June, 1918, was £7.771 per ton at Avonmouth, as against £8.354 at Queen's Ferry, despite the fact that at the latter factory the output was 25,300 tons, as against Avonmouth's 3,800 tons (the Avonmouth cost includes the charge for administering the works costs office). It would, of course, be absurd to argue that the whole of the saving of £0.583 per ton was a direct result of the Avonmouth costing system, but, on the other hand, the fact that the economies effected were in labor usage (£0.56 per ton, as against £0.70) and maintenance charges (£0.138 as against £0.695) does indicate quite clearly that the technical staff were striving for economical manufacture. For this and for some of the success which attended their efforts full credit should be given to the system of daily cost analysis.

The development of works accounts is, of course, a part of the general movement in industry for "efficiency"; but works accounts, with their detailed cost analyses, and "efficiency" are not synonymous terms. The value of accurate information as to production costs lies in its application to the problems of production, and therefore is in the hands of the technical chemist.

Real estate, plant equipment and manufactured goods and raw materials on hand of the Industrial Chemical Co., East Providence, R. I., will be the subject of receiver's sale on the premises on September 15. The plant is fully equipped for the manufacture of direct and azo colors. The property is to be sold, free of all encumbrances, mortgages to be settled by the receiver out of the proceeds. Ten per cent. of the purchase price is to be paid on acceptance of bid and the balance on delivery of deed to the property.

*The main items were raw material, fuel, water, steam, lighting, power, process and labor charges, maintenance and repair labor charges, workshop costs, stores issues, overhead charges.

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A Consolidation of
The Chemical Engineer
and Chemical Age



NOW comes Government seeking to save the misguided from the results of their own folly.

If President Harding's proposed conference on unemployment will emphasize the causes of non-production and the respective responsibility of the various elements of industry to serve a world needful as never before, its educative influence may bend the refractory to an appreciation of their true place in the scheme of things; and thus contribute to a humbleness of spirit demanded of consecration to an ideal which considers the good of all rather than the advantage of any class.

To focus public attention upon errant numbers of a great cooperative body and to point out the way of salvation, is all that Government should do, and in justice to all can do, to cure ills that properly only Nature can correct.

THE essence of patriotism is cooperation—demanded no less in peace than in war and denied in the former only at the cost of distress which in the latter means defeat.

Patriotism is the last acquired and least firmly fixed of human attributes, and the first discarded in the scramble for self. It is a product of experience in which education plays a dominant part.

If President Harding's conference will serve to bring home to those who need it most, that no class, no more than no man, liveth unto itself alone, it will do much to inculcate individual and group responsibility for the common good.

JUST as Professor Lovelace points out in this issue of CHEMICAL AGE that the gains of science are at a greater rate than the capacity of industry to utilize, so power inherent in group action often comes faster than the capacity of its intelligent use.

We have as example of the latter phenomenon the growing tendency to look to Government for service foreign to its legitimate functions and which must be left to private initiative if freedom of opportunity and the common rewards of ability are to be preserved.

Group selfishness, whether expressed in a scheme to operate railroads for the benefit of railroaders; or a more embracing conspiracy to obtain exemption at the common cost from the operation of natural law, or the conduct of a Government fertilizer-material plant ostensibly for farmers, or as enforced gratuity or special service to any class or industry, subverts the common welfare which is the primary concern of Government.

THE demonstration of the potentiality of a chemical industry to produce in the same plant allied products at once essential to the adornment of civilization and the maintenance of health, and capable of their destruction, not only was the outstanding revelation of the war, but one that promises more than any other aspect of the conflict to affect the future economy of the world.

To deprive Germany of her monopoly of the products of the organic chemical industry, which have this almost dual individuality, and to create within their own boundaries self-sufficient and independent enterprise, of the same character, every allied nation but the United States was prompt in enacting effective measures.

In contrast therewith, the organic chemical industry of the United States, born of the throes of war and whose products absolutely were essential to its termination, has been subjected to an uncertainty as to its preservation astounding to those who appreciate the peril of the situation.

With every dyestuff plant a potential arsenal, the attitude of politicians that would permit the destruction of the American dyestuffs industry by refusing a brief and effective period of protection until such time as skill is an intricate art will have been acquired, is the nearest thing to aid and comfort to an unrepentant enemy in the history of American politics.

THE present aspect of deflation most prominent is not its final laggard steps but that alignment of the great staples and their products in a way to express a normal price relationship one to another.

Much adjustment in labor costs remains to be effected, particularly in the manipulative and distributive processes, before goods, beyond hand-to-mouth requirements, can be made at a price that will encourage steady consumption. Abetted by demagogues, labor demands a wage rate which, reflected in prohibitive prices, conduces to unemployment with that further aggravation of the incapacity to buy which means stagnation of production.

Wage readjustments are inevitable and recalcitrancy only can prolong distress felt most by those who inflict it upon themselves. Labor's salvation lies in increased productivity that goods may be cheapened by reduced labor costs per unit. Production is a cooperative process that requires from each element of cost its respective contribution to efficiency that all may prosper.

WHEN one considers that accumulation of capital, inventive ingenuity and transportation are the foundation of the structure of present civilization, he need not be surprised at any evidence of strain in the face of the shocks of the past seven years to which the foundation has been subjected.

The destruction of capital by war not only has created for it an unprecedented demand but has left impoverished the regions that now can profit most from its use. Time only can lighten the burden put on thrift.

Political abuse of transportation and the unwise use of power by those whose livelihood it has hamstrung a great agency of service.

Inventive ingenuity, that has made possible the leisure man enjoys, watches no time clock but seeks ever to make more productive the 8-hour day, and receives the commendation of the charge that the repetitive processes of industry are dulling the human mind.

RECOGNITION of the importance of export trade as the outlet for the surplus of American production, for which not only is there no domestic market and which is essential to that capacity operation which carries the lowest unit cost, and growing appreciation of the fact that tariff restriction will find its reflex not only in similar legislation abroad and in strengthened disparity of exchange, but inability to pay for American exports and war indebtedness by exchange of commodities—the only feasible way, lie at the basis of the delay of prompt conclusion of the tariff agitation which of itself is a prime cause of uncertainty in American industry.

The demand for cooperation in the international relations is as pressing as in the domestic relations of industry.

The withdrawal of any nation, particularly the United States, from necessary participation in the economic restoration of the world, such as is involved in artificial and natural restrictions that paralyze the will to pay, not only will postpone recovery indefinitely but will deny the ultimately greater domestic gain from such participation.

NOTWITHSTANDING campaign promises and the desire of their fulfillment, we cannot escape the burden on industry of the tax legacy of the war. Nevertheless taxes can be levied in a way not to penalize enterprise, by shifting the incidence from organized thrift, which has dried up, to spending.

The wholesome universality of the sales tax is disparaged by politicians who know they never would be forgiven for bringing home to the voter his inescapable responsibility for government and who find safety in measures which augment the burden but which conceal its incidence. Statesmen are not above the practice of the homely psychology that what a man does not know won't hurt him, or at any rate hurt so much.

AT a time when we have a surfeit of panegyric to the attainments of the chemist, let us look at him as a man. Of professional men only the physician surpasses him in necessary mental qualifications for initial practice. No class of educated industrial workers is so poorly paid or moves in an environment that makes such compelling demands upon affection for one's work.

While it is impossible to indicate the relative level of mediocrity in professional work, all, especially teachers and industrial executives, admit that it is high; which has its direct reflection upon remuneration, for in production men are paid not for what they know but for their ability to translate it into dollars and cents.

Of direct bearing upon remuneration is the fact that the chemist is a tool ever subordinate to the man, whether technically educated or not, who knows how to use the tool, *i. e.*, who has executive capacity in the display of which lies the future of the chemist in the work of production. The chemist as a class is top-heavy mentally, without that ballast essential to maximum dividends on the investment of time and money in his preparation.

Chemical industry rewards not the analyst whose duties are the hack-work of production, nor the research man who discloses new vistas for making money, nor the plant man who runs a chemical machine. It rewards the man who uses these men from whose ranks he comes by natural selection.

What the chemist has to sell is service. His education and segregation are concerned exclusively with pumping him full of scientific principles and the endless facts of the behavior of matter, with little or no regard to his capacity to use or sell them.

The organized cultivation of material efficiency, in contradistinction to the mutual admiration of the educational society, is ignored and wastefully so, for men who have service to sell organize professionally not for oppression incident to class aggrandizement but to render more efficiently a worthier service.

There is a place in industry for every ambitious man. The problem before chemists as a class is to help their fellows to find that place.

The two most effective instruments for the development of the latent potentialities of the chemically educated man lie (1) in professional organization to aid natural selection in the process of growth, and (2) in the cultivation of popular interest in chemistry whereby a man may gain from what he gives away.

The activities of the New Jersey Chemical Society, in promoting on one hand a professional organization of chemists, and on the other demonstrating in a brief period, unmatched for usefulness in the annals of chemical organization, the value of co-ordination and concentration of the chemical interests of a state in a state chemical society, have set a precedent for public spirited chemists in other states similarly to show the value to the individual of these two instruments of growth.

Cellulose Acetate in Artificial Leather Manufacture

By Maurice Deschiens

Ingenieur Chimiste. Conseiller Technique de l'Aéronautique de France.

THE production of artificial leathers, which has reached so high a degree of perfection in the United States, has up to the present consisted almost entirely of nitrocellulose as the cellulose ester base, combined with vegetable oils to induce plasticity and suppleness, and containing pigments, lakes and dyestuffs to impart the desired shades. Fabrikoid, Duratex, Keretol, Morocoline, Textileather and Cortex are representative trade names for pyroxylin coated textiles, which when embossed find a large sale for upholstery for furniture and in the automobile industries and for covers in book-binding.

It was L. Lilienfeld who in 1914 first called attention to the manufacture of artificial leather of the type in which a textile fabric or paper is provided with one or a plurality of coatings of a cellulose ester compound as cellulose acetate or celluloid together with a softening agent, substituting wholly or in part for the oils and fats previously used, a softening agent of a phenol ester remaining liquid at 0° C. as *o*-tricresyl phosphate. According to this inventor, the solution of the cellulose ester is further improved by the addition of such filling and supple-inducing materials as caoutchouc, gutta-percha or drying oils, or with filling substances as ground leather or cork, asbestos, powdered kaolin or chalk. So far as aware, this process has as yet received no extensive technical application.

According to the patented ideas as advanced by the Raison Sociale Siebert, waxed and coated cloth and paper may be satisfactorily prepared by the use of cellulose acetate as a substitute for fats, oils of paraffin hydrocarbons, the method being to first cover or impregnate the cloth or paper with successive thin layers of linseed oil or acetated cellulose, alone or together, drying after each application, and applying a heavy solution of cellulose acetate dissolved in a combination of low and high-boiling direct solvents as acetone and tetrachlorethane, with quick drying non-solvents as benzene. After the final drying, the material is embossed or otherwise ornamented, and may be printed. For colored waterproof effects, acetate lacquer may be dyed with basic dyestuffs previously brought into solution by means of ethyl alcohol, the oil coats being dispensed with. Methyl green, Victoria green, aurine, auramine, fuchsine and saffranine are suitable coloring matters for this purpose.

In the W. Balser process, fabrics are rendered impermeable to Roentgen rays by adding to the fabric as a coating composition, an acetone-soluble cellulose acetate in which has been incorporated certain heavy metal oxides in a minute state of subdivision. Such fabrics are alleged to be superior to pyroxylin coated textiles in that the decomposition of the nitrocellulose with the

liberation of free nitric acid is obviated by the use of the acetic ester of cellulose.

In the manufacture of cellulose acetate artificial leathers—both for upholstery and book-binding purposes,—the minimum of solvent should be used to dissolve the acetated cellulose for economical reasons, and where a volatile catalyst has been used in esterifying the cellulose, such as hydrochloric acid, the cellulose acetate may be used in the original acetating mixture at the point where the maximum hydration has taken place, and before the ester has been precipitated out.

In this manner, the viscous solution may be directly spread upon the textile, either alone or in combination with dyestuffs, the coated cloth being then run through warm water in order to precipitate the acetated cellulose and remove the acetic acid therefrom. A final coat of cellulose acetate dissolved in acetone and benzene, with a small amount of high-boiling solvent as benzyl acetate, triphenyl phosphate or the toluene sulfonamides, is applied, the cloth being embossed in the usual manner after the removal of the solvent portion in the usual manner. By proceeding in this way, the amount of solvent employed may be reduced materially, with a corresponding reduction in cost of the



MAURICE DESCHIENS
Ingenieur Chimiste. Conseiller Technique
de l'Aéronautique de France

finished product.

In a modification of this method, plasticizers are added to the original acetating bath, and after the cellulose ester has been precipitated on the cloth by washing, the coated textile is next dried by passing over and under a series of steam-heated calendar rolls, whereby the friction motion together with the presence of the plasticizing agent, is said to impart a smooth and uniform finish to the cloth, which, when embossed in the usual manner, results in a finished article of commercial acceptability.

Cellulose acetate compound fabrics, such as described by the Société Anon, des Celluloses Planchon, for instance, may be prepared by spreading a cellulose acetate solution on a polished surface and allowing the solvent to evaporate, after which a suitable textile fabric such as tulle is moistened with a solvent of cellulose acetate, and the film incorporated with the textile by applying one to the other under pressure. The compound fabric is then stripped from the polished surface. Artificial foil is made by these patentees in much the same manner by converting artificial hair into foil by passing between rollers such as are employed in the manufacture of metal foil.

While it is true that the industry of cellulose acetate leather production is still in its infancy, there are so many varieties of acetated cellulose which may be produced by the hydrolysis operation which finds no counterpart in the nitration of cellulose, and the num-

ber of solvents, high-boilers and plastifying agents are so numerous and varied in their physical properties, that this industry appears to offer practically unlimited possibilities, and awaits only further reduction of experimental results to commercial application, to

provide active competition in this field of cellulose ester activity, as it has more specifically in the formulation of airplane dopes and coatings, the manufacture of acetate artificial filaments, and in the manufacture of inflammable photographic films.

Louisiana Natural Gas and Carbon Black Manufacture

THE Monroe natural gas field, which is held by the people of Louisiana as one of the state's most valuable assets, has the greatest potential capacity of any known gas area. The proven productive area is about 212 square miles with a productive horizon of an average thickness of not less than 50 feet. The initial rock pressure of the gas of about 1050 lbs. per square inch has shown no appreciable decline since the "Discovery Well" was drilled into the gas rock in 1916.

The northerly limits of the field have not yet been reached. Several wells completed within the past three months indicate a certain addition of at least fifty square miles to the productive area, with a strong probability that the area will eventually be found to be in the neighborhood of four hundred square miles.

The Supply of Gas

Any attempt to estimate the quantity of underground gas is based on many uncertain factors and is best but an approximation. From present data as to the extent and productivity of the field, it is estimated to contain a volume of gas which, if totally recoverable, would supply gas at the rate of 100 million cu. ft. per day for a period of 130 years.

It is not to be assumed, however, that all this gas is recoverable or that all the gas recoverable will be available for consumption. The former is a function of the amounts allowed to waste underground, and into air through wild and blowing wells, of the effect of water infiltration and of the amount remaining after commercial extraction has ceased. The latter is a function of efficiency of operation and distribution. With the highest efficiency in the utilization of this mammoth reservoir, it is believed that the field should yield a recovery of 150 million cu. ft. of gas per day for 43 years. It is estimated that 90 billion cu. ft. of gas already have been withdrawn. The gas does not run of uniform quality throughout the field. Gasoline absorption plants located in different parts of the productive area report a gasoline-content per million cu. ft. varying from 20 to 200 gallons, the lower figure being below the limit warranting recovery operation. The greatest known depth of gas rock below the surface is 2300 ft.

Recovery and Use of Gas

Of the 105 wells drilled in the field, only 88 are within the area of proven productivity; of these only 65 are in condition to supply gas and only 36 are actually supplying gas for commercial purposes. The underground waste from one well alone is estimated at 10 million cu. ft. of gas per day. The 65 wells considered to be in a condition to supply gas have a combined open-flow capacity of 620,467,000 cu. ft. of gas per day. The average daily reported production for February, 1921, was 77,840,000 cu. ft. per day, or 12½ percent of the combined open-flow capacity of the field.

The reported production, however, is drawn from only the 36 wells above mentioned, which have a combined open-flow capacity of 324,507,000 cu. ft. per day. The reported production for February, 1921, therefore, is 24 percent of the combined open-flow capacity of the wells supplying the gas. Of this volume of gas 91.3 percent was delivered to carbon black plants, 3.1 per-

cent to industrial consumers, 2.9 percent to domestic consumers, and 2.7 percent unaccounted for. During the year ending March 1st, 1921, 19,206 million cu. ft. of gas, or 90 percent were used in carbon black manufacture.

In compliance with the regulations of the State Department of Conservation, that before any carbon black manufacturer can utilize any natural gas in Louisiana containing gasoline in quantities sufficient to make its extraction profitable the gasoline therein must be extracted and saved, most of the carbon black plants are operated in conjunction with gasoline plants of the absorption type. From the same gas consumed to make carbon black there is first extracted upwards of ten thousand gallons per day of high-gravity gasoline, which, when blended with low-grade naphthas, yields nearly double the amount of commercial gasoline.

On April 1st, 1921, nine carbon black plants were in operation in the field, with substantial additions to two under way and two new plants in process of construction. Total actual operating capacity embraced 34 units comprising 707 burning houses with a combined capacity of over 80 million cu. ft. of gas per day and with an actual average daily consumption during February, 1921, of 71,044,000 cu. ft. of gas. With full capacity operation the total daily production of carbon black of all grades was estimated at 71,000 lbs., or about 1 lb. for each 1130 cu. ft. of gas consumed.

Handling the Gas—Its Use for Power

The gas from the wells is usually piped to the plants at a pressure of about 225 lbs. per sq. inch. This pressure is reduced to about 55 lbs. per sq. inch by a regulator on the plant property. The gas is then passed through a low-pressure regulator to a gasometer carrying a pressure of one or two inches of water. From the gasometer it is distributed to the burning houses and is burned at a pressure of a few tenths of an inch of water.

All power used in the carbon black plant is generated by gas expansion. This power includes that used to operate the machinery and to furnish electricity to light the plant. Gas at the intermediate pressure of 55 lbs. per square inch, after being heated by passing the line through a burning house, is expanded through steam engines to supply power and through turbines to generate electricity. This gas is exhausted into the gasometer and distributed, with the main volume of gas, to the burning houses. In at least one plant gas is used to jet water from a well and is then collected and passed to the gasometer. Where gasoline plants are used to extract the gasoline some gas is burned as fuel to generate steam. This steam operates the circulating pumps and is exhausted into the stills.

Pipe-Line Distribution

There has been much discussion concerning the feasibility of piping gas from Monroe to the various proximate centers of population. The short season of heavy domestic consumption probably has been the principal deterrent to such projects. Under these circumstances it is plainly evident that in order to supply the needs of the homes gas must be sold for the use of industries.

A pipe-line meant to deliver gas only for domestic purposes must be large enough to handle the maximum requirements and therefore will be working at low capacity for nine or ten months of each year. Reasonable returns on the investment could not be expected for a long line under those conditions.

An industrial load, therefore, must be applied to maintain a uniform load as far as practicable, in order to supply domestic demands at a reasonable price and to make the project financially attractive to private capital. In this connection it may be found feasible or necessary to limit or discontinue the industrial use of gas during the several months of cool weather.

The distance from Monroe to various cities are as follows:

St. Louis, via Pine Bluff, Arkansas and Memphis, Tenn., 530 miles; Kansas City, via Pine Bluff, Little Rock, Joplin and Pittsburg, Kans., 505 miles; Houston, via Alexandria and Lake Charles, Louisiana and Beaumont, Tex., 330 miles; New Orleans, via Natchez and Baton Rouge, 250 miles; Memphis, via Pine Bluff, Arkansas, 240 miles; Arkansas cities, to Pine Bluff, connecting with the system of the Arkansas Natural Gas Co., serving Little Rock and Hot Springs, 105 miles.

Many interests advocate the construction of pipe lines to these cities, not the least important of which are manufacturers of pipes and builders of pipe lines, although other interests naturally are the industrial enterprises of the respective communities.

Carbon Black Manufacture

With the assembly of the state legislature in September, it is expected that the uncertainty that confronts the enterprise of carbon black manufacture will disappear in the mutual concessions always necessary in the settlement of issues that touch in a broad way the public interest. We, however, witness a sharp division of opinion, one side seeking to protect the carbon black makers, with large capital investment and providing a product of intimate indispensability to modern civilization and of daily increasing importance in its ramifying usefulness in rubber products and printers' ink manufacture which consumes 70 percent of the total annual production, and the other side condemning carbon black manufacture, notwithstanding the direct relation of abundance and cheapness of its product to human literacy and cheap automotive maintenance, as a wasteful utilization of one of the most valuable resources of the state.

The recent Constitutional Convention endowed the state legislature with power either to regulate carbon black manufacture or to prohibit it outright by the following Section 1 of Article 4 of the new state Constitution:

"The Legislature shall enact all laws necessary to protect, conserve and replenish the natural resources of the state, and to prohibit and prevent waste or any wasteful use thereof."

It is contended, with a show of consideration, that when the plants now operating in the Monroe field were constructed, there was no present and perhaps no reasonably prospective market for the gas and that this fact should have due weight in any legislation designed to affect the carbon black industry.

The carbon black manufacturers further point out that they were the pioneers in this field; that their capital and energy were chiefly responsible for its initial development; that they risked several hundred thousand dollars in buying lands and drilling wells at a time when the extent of the gas area was purely conjectural;

and that it is hardly fair that they should now be deprived of the right to use the gas which they have discovered and developed on their own lands by their own effort and expenditure.

They also emphasize that the conversion of natural gas, by the best known methods, into a product so essential to civilization as printer's ink can hardly be deemed a waste of a natural resource, particularly at a time and place where there is absolutely no other market for the gas consumed in their manufacturing operations, and where the closing of their wells would result in underground waste probably exceeding their present consumption.

They also emphasize that the present laws of Louisiana adequately safeguard the public against the immoderate exploitation of natural gas resources by any interest. Under existing laws, the following restrictions are imposed: First, not more than 25 per cent. of the capacity of any well may be taken. Second, all gas must be metered and monthly production reports rendered to the Department of Conservation. Third, no new carbon black factories may be erected without license from the State. Fourth, the gasoline must be extracted wherever the gasoline-content is sufficient to justify. Finally, a severance tax is collected by the State on each thousand feet of gas consumed.

The importance of the printed page of its cheap and universal dissemination are linked directly with the situation that confronts carbon black manufacture in Louisiana, to say nothing of the import of the subject to millions who ride on rubber.

The entire controversy illustrates to some extent the prevailing tendency to substitute legislation for the operation of economic laws. If the gas production of the Monroe region can be marketed for domestic or other industrial purposes at prices that will compare favorably with what can be realized by converting it into gasoline and carbon black, it will undoubtedly be sold and used for those purposes, and carbon black manufacture will automatically decline. One who invests his capital in the hazardous business of producing oil or gas is entitled to a return for his money and effort, and should not be denied the right to sell or use his product profitably.

The solution of the problem would seem to lie in the direction of developing a broader market for gas, which will absorb the vast surplus now wholly unmarketable. Such would seem to be the view of the engineers of the Bureau of Mines, who state in their recent report that "it does not seem advisable to allow the present extraction of gas from the field to be increased for the purpose of manufacturing carbon black unless it be definitely determined that the gas of the Monroe field cannot be made available for use as fuel, but it does seem advisable to allow the present plants to operate until another market is developed, which will make for higher conservation of the gas they are now using."

The Corn Products Refining Co. reports 75 per cent. capacity operation, with a daily grind of 150,000 bushels of corn. The completion of its new Kansas City plant by the first of the year will add 25,000 bushels to its present daily capacity of 155,000. The shortage of the German potato crop has turned German users of starch products to American starch, with consequent improvement of the company's German business. The use of glucose in candies, syrups, preserves, mincemeat, etc., to prevent the cane sugar from crystallizing and to give better color, makes the demand for this product independent of the price of sugar.

Manufacturing Costs Must Be Reduced

The Solution of Our Economic Problem Is Increased Production Per Man

By Sanford E. Thompson

Consulting Engineer, The Thompson & Lichtner Co.

OF what use is it to sell goods at prices below the cost to replace? In order to meet reduced purchasing capacity, expressed directly in the widespread demand for lower prices, and to continue manufacture, the cost of production must be reduced. The shortness of our business depression, the rate at which business returns, and its permanence, will be governed by the manner in which this is accomplished.

During the period 1917 to 1920, direct labor costs were rising far faster than wages. As typical of this we find from the books of a manufacturer that while the cost for direct labor alone on a certain article was \$2.85 in 1917, in 1918 it was \$3.20, in 1919 \$4.42, and in 1920 \$6.60, and that during this period in which these direct labor costs had thus increased 140 per cent, wages had risen only 80 per cent.

The difference between these two percentages, then, means a lessening of production per man, and similarly, the increase in direct labor costs might be referred to the increase in percentages of profit that market conditions made possible. Surely under such conditions the worker cannot buy, and since the worker is the chief consumer our plants must lie idle until some of these excess values are eliminated.*

Manufacturing Costs Must Be Reduced

We must not only get back to normal production per man and to normal profits—we must go further. Manufacturing costs must be reduced to even a lower level than before the war¹ and this must be done without reducing wages in like proportion, for at least a part of our higher living standards must be maintained and our progress must continue to be upward and not downward.

But merely lowering wages and lengthening hours of labor will not produce the result, for by lowering wages beyond the point necessary to balance recent inflation both purchasing power and consumption are also lowered.

In India wages are low; a skilled laborer works for one rupee, 29 cents per day, or approximately, one-thirtieth of our present rate in America. And why? A relative in India writes me that it took his native painter twenty-four days to put one coat of paint on his Ford car—and this was record time. Low production per man which necessitates such low wages is the cause of India's poverty, and it explains why the Hindoo has not money enough to buy his rice and the strips of cloth that serve for clothes. It illustrates the fact, moreover, which is generally recognized in theory but not always appreciated in the practice, that the only solution of our economic problem is a greatly increased production per man.

Soon after the close of the Civil War there was a marvelous development in machinery which was chiefly responsible for the continuous increase in wages for a period of some years following. We may secure further developments through machinery but we cannot definitely count upon them.

The developments of the immediate future, that will reduce costs and that will increase production, will be

through methods and men; the development of methods in co-ordinating and simplifying the operation of machine and hand processes, and the adoption by both employers and employees of the principle of the fair deal and the golden rule. Both of these are essential, as production development which is not from the heart is futile.

Only Thorough-Going Plans Will Succeed

But satisfactory results cannot be attained through superficial recommendations, nor by short-cut methods. The only plan which will produce real success is that which studies causes, shows in advance what should be done, analyzes the conditions, adapts special methods to the particular plant, studies processes, and saves materials. It is the classification of facts, the job analysis, the intimate study of conditions, the standardization of methods, and the development of a plan of actual control, that produce the real results in output and in cost reduction.

It is through such methods as these that it is possible to eliminate unnecessary operations, determine the best equipment and machinery, standardize methods and quality, and above all, create enthusiasm in the worker. It may be said that these objects are not novel, that every manufacturer is striving his utmost to achieve one or more of them. Agreed, but this is just the trouble; he is attempting merely one, or two, and he fails. There is scarcely a problem in the factory but involves thorough analysis, control of work, and development of the worker, in order to produce effective results.

Ordinary vs. Scientific Methods

The distinction between the methods which must be followed and the ordinary plan is this: The one, the ordinary method, attacks simply the obvious and demands quick results, overlooking the basic principles of scientific development. On the other hand, essentials of the treatment which make for large and permanent increase in production and which make for reductions in costs measured not by thousands but by hundreds of thousands of dollars, include an analysis of the work to eliminate unnecessary operations and to standardize methods; the development of a control which actually plans out the work in advance so that the workers get their jobs and materials just as they are needed to use on the jobs; and finally the creation of enthusiasm in order to induce the worker to take a real interest in his work.

The Vital Principle in Management

The development of control under old or traditional methods of management has been as little appreciated as analysis itself. In fact, even now some manufacturers little realize the absolute necessity for the control feature of the plan and are satisfied with a system that simply follows and keeps track of the work that is being done instead of actually planning it out in advance and arranging for distribution of materials and jobs.

In speaking of such control in a factory, we do not have in mind the authority of the manager and of the foremen over the workmen and the flow of material, but refer to the more recent functional control, the control that relieves the officials of petty details, that assigns

*Management Engineering, July, 1921.

¹ In referring to costs as lower, necessarily, of course, be taken of any variation in money standard. For example, if the value of money continues low, costs in terms of money may remain permanently at a slightly higher level than before the war, even though intrinsic costs are really lower.

the various features of the management to those who are best fitted for handling specific duties, and, as we have just said, actually plans out the work.

This is a vital principle in modern management, and as a matter of fact, the very largest saving possible in a manufacturing plant is usually through the balancing up of operations, and departments; the avoiding not only of the small delays of operation but the big delays due to the ups and downs of varying products and irregular flow. This can only be accomplished through planning and control.

More and more along these lines must be the trend of modern manufacturing. Even in other features besides direct production methods — standardization of product, maintenance of quality, elimination of waste — must the same principles be applied. We must have analysis to determine standards, control to maintain them, and, fully as important, development of the worker to obtain his confidence and co-operation.

Recognition of Worker as a Man

In this phase of the plan the personality of the worker must be recognized as one of the features to receive most careful attention. In developing new methods one of the easiest problems is to obtain the

co-operation of the worker in testing out the plan. When actually starting work, however, there is apt to be a difficulty in making the right start no matter how honest and conscientious the worker. The worker is used to haphazard methods, and though starting out he may go well, later, not realizing the necessity for following the best method in every case, he is apt to fail. Encouragement, teaching, and fair play are essential in producing the ultimate results.

Moreover, the developments that have been described go a long way in themselves toward satisfying the worker. By planning the work delays which are so exasperating to the worker will be avoided; by routing the work and materials a fair assignment of jobs not one day in the week but every day in the week will be obtained; by analyzing the operations in detail it is easily shown how the work can be done; and finally by prevention of defects in materials penalizing the worker through no fault of his own is avoided. The men, too, may feel that in doing their work well they have the satisfaction of accomplishment.

These conditions make for the permanent contentment of the worker, as well as for that increase in production and lowering of costs which must be attained if our economic problem is to be solved.

Utilization of Pine Waste

By Joseph H. Wallace

Of Joseph H. Wallace & Co., Industrial Engineers

THE lumberman and naval stores operator have been for years destroying the virgin pines of the South with reckless extravagance. Only about one-third of the tree ever reaches the market in the form of lumber, lath, or shingles, while a few years of the wasteful American method of tapping turpentine from the living tree are sufficient to cause its death. In place of the forests of yellow pine which a generation ago covered more than one-quarter billion acres of land in the South, there exists today an expanse of desolate barren studded with stumps blackened by the fires which from time to time sweep over them.

The yellow pine stumps do not send up a second growth like the northern deciduous trees, and because of their resinous nature, do not decay in a lifetime. They remain an obstacle to agriculture and the development of the land.

Because of the expense of removing them, not more than one-tenth of this cut-over land has ever been reclaimed for agriculture or grazing, in spite of the fact that there remains locked up within these stumps a potential wealth far greater than was obtained from the trunks that have given their substance to naval stores and lumber industries.

Methods of Utilization of Pine Stumps

For three-quarters of a century engineers, chemists, and business men have endeavored to devise means to unlock this underground storehouse of wealth. The efforts of the inventive genius have been directed mainly along three distinct lines. The first to be suggested was the destructive distillation of the stump and trash wood. This produced tar, pitch and charcoal having sufficient value to offset a portion of the cost of clearing the land. These processes have been developed recently and have become moderately profitable, particularly on account of the value of flotation oils for use in the mining industry.

The second scheme of reclaiming this underground wealth was to cut the wood into fine chips and then

steam in a closed vessel under sufficient pressure to distill off the turpentine, the steamed wood then being dried and used for fuel. This became profitable when it was found that after steaming, the wood could be used as a source of supply of rosin by extraction with a solvent. This modified plan, known as the steam and solvent process, is now operated successfully, and with a profit in many locations.

The third proposal was to utilize the fibre of the wood for making pulp and paper. This could be done only with difficulty by the acid pulp methods most common to the industry, because of the extremely resinous nature of the wood.

The enormous waste of the yellow pine wood in the South Atlantic and Gulf states attracted our attention in 1906. We found that the pulp mills of Sweden were successful in making pulp, by means of the sulphate process, from wood containing considerable resin. We began experiments with a view of utilizing this waste as raw material for the manufacture of chemical fibre and paper, and after a demonstration in the laboratory made an actual commercial run in a Swedish mill on a load of resinous pine waste material from the Southern states. This test was successful, and as a result we designed and erected (1912-1913) the mill of the Southern Paper Company at Moss Point, Mississippi. This mill was operated for three years under our supervision, and during that period produced chemical pulp and Kraft wrapping paper at a lower cost of production than has ever been obtained by any other plant in the world. This plant thoroughly demonstrated the value of the waste wood as raw material for pulp and paper, and several plants of a similar character are now operating profitably along similar lines.

There exists, then, three distinct methods each of which is successful, but none of which recovers any great percentage of the potential wealth of the stump and logging waste. Both the destructive distillation and the steam and solvent methods result in the destruc-



Panoramic View of Hackensack Meadows Along the

A "Chemical" Analysis of the Jersey Meadows

By E. J. Maier

Secretary, Louis Schlesinger, Inc.

TO the average commuter or traveler by rail or by motor New Jersey loses its picturesqueness when the Great Newark Meadows are reached, and the journey then becomes one of tolerance. Smoke-filled air, combined with the conglomeration of disagreeable odors and a monotonous view of the flat meadow lands stretching as far as the eye can see, spotted here and there with hideous-shaped and discolored buildings, and smoke stacks, make the brakeman's command "shut yer winders, please," a welcome one which is promptly obeyed by some.

To the experienced chemist or engineer whose life work may be the converting of a car load of coal into the dyestuffs for the beautification of miladi's gown, or into the medicinal chemicals to be dispensed at the corner drug store, or the transformation of a ship load of cotton into the celluloid to be used in the manufacture of thousands of novelties, or who in innumerable ways reclaims the natural elements of the products of the earth and field and air for use in the everyday necessities without which these very commuters or travelers could not exist—to these trained men the beauties of New Jersey loom up more prominently when they approach the meadows, and on close observation they may be found to be the men who disobey the brakeman's command and leave their windows open so that they may enjoy the scenic grandeur of the mountains of coal and coke and breath in the nitrous fumes which to them is ozone.

The meadow lands bordering on Newark Bay, the Passaic and Hackensack Rivers unquestionably have become a tremendous asset to the chemical industries, and this fact is evidenced by the great number of chemical plants of every kind which have been established there.

Essentials of the Plant Site

The principal factors which go to make up an ideal location for industries of this character may be classified as follows: (1) unrestricted use of the land and an abundant water supply; (2) the best facilities for receiving and shipping materials in large or small quantities by rail or water; (3) close proximity to a labor market furnishing common labor, and within a reasonable distance and easy travel of the better-class residential section; (4) close proximity to New York where the general offices are best located, and from which port shipments for export may be made with a single transfer; (5) convenient rail or water connection with the raw material base of supply, making it

possible to receive car load or cargo at the plant door without rehandling.

The relative value of these factors in the various branches of the industry may differ somewhat, but when the whole is summed up it may be found that a location in the vicinity of Newark Bay and its tributaries, which lies within gun shot of Manhattan Island and is still isolated from encroachment by residential objectors by the protecting marsh which surrounds it, makes it possible to carry on those processes of manufacture which would meet with serious objection in localities in closer proximity to dwellings. These are the features which make this one of the best locations for the efficient production of most chemicals.

The Growth of a Decade

It may seem strange that a section with so many natural facilities should lie dormant all these years, for it is a fact that the most noticeable upbuilding has taken place during the past ten years. A great impetus took place during the war when the emergency necessitated the harnessing of all the natural resources. It was then that many of these large chemical plants were erected along Newark Bay or the Passaic River to make the chemicals of warfare including enormous quantities of gun cotton to "win the war."

Since the signing of the armistice this scene has changed and a newer life and another kind of activity are taking its place. The Government, through Congress, has acknowledged the service by awarding a lasting medal in the form of the deepening of the channel in the Newark Bay to make this expanse of marsh lands more valuable in the progress of industry.

Added to all the natural advantages and to the great freight terminal and classification yards which are equalled no where else in the world, the deepening of the channels of Newark Bay will make this an inseparable part of New York Harbor.

The City of Newark has already expended over \$4,000,000 in the development of Port Newark Terminal, and its Director of Streets and Public Improvements has authorized the expenditure of \$1,250,000, for the immediate deepening of the channel in Newark Bay from the existing thirty-foot depth in the Kill von Kull to and including the city's own channel at its Port Newark Terminal development. This gives Newark and its meadow lands a thirty-foot water way to the ocean.

The work was actually begun on June 8th of this year and will require about 500 work days to complete it. The project also includes the erection of retaining bulkheads and the reclamation, hydraulically by the



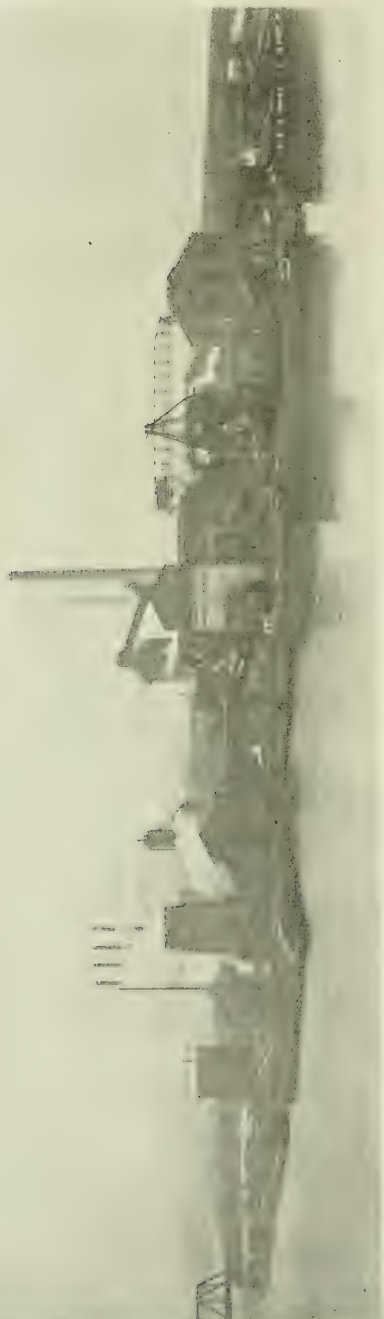
Passaic River at Newark, New Jersey

Map of Newark Bay and the New Jersey Industrial Region Adjacent to New York City

- | | | | |
|--------------------------------------|--------------------------------|---------------------------------------|-------------------------------|
| 1—American Agricultural Chemical Co. | 10—Columbus Crystal Co. | 21—Niles-Bement Pond Co. | 30—Tanners Products Co. |
| 2—American Splint Co. | 11—Martin Dennis Co. | 22—Organic Salt & Acid Co. (A. D. S.) | 31—Texas Oil Co. |
| 3—Atlantic Smelting & Refining Co. | 12—Dye Products & Chemical Co. | 23—Prest-O-Lite Co. | 32—Tower Manufacturing Co. |
| 4—Baker Coconut Co. | 13—Egyptian Lacquer Mfg. Co. | 24—James H. Rhodes Co. | 33—White Tar Co. of N. J. |
| 5—Balbach Smelting & Refining Co. | 14—Thomas Edison Co. | 25—Schofield Oil Co. | 34—Standard Chemical Co. |
| 6—Butterworth-Judson Co. | 15—Federal Shipbuilding Co. | 26—Seaboard By-Products Coke Co. | 35—North American Copper Co. |
| 7—C. W. H. Carter & Co., Inc. | 16—Ford Motor Co. | 27—Mutual Chemical Co. of America. | 36—Oil Seeds Co. |
| 8—Celluloid Co. | 17—A. Gross & Co. | 28—Submarine Boat Corporation. | 37—Gulf Refining Co. |
| 9—Colgate & Co. (proposed plant). | 18—Heller & Mertz Co. | 29—Sun Oil Co. | 38—Pacific Coast Borax Co. |
| | 19—Indian Refining Co. | | 39—International Smelting Co. |
| | 20—Ladew Leather Works. | | 40—American Cotton Oil Co. |



use of materials excavated from the channel, of about 300 acres of additional land which with the completion of a new highway known as Hayes Avenue, a diagonal thoroughfare running across the meadows from Port Newark Terminal to the heart of the city, makes all this property available for factory purposes.



New Plant of Seaboard Bu-Products Co.,
on Hackensack River, Kearny, N. J.

U. S. Senator Walter E. Edge

With reference to the development of the future of what promises to be one of the greatest ports of the world, Senator Walter E. Edge of New Jersey, recently said: "I want to emphasize the fact that this project is in no sense a local one. The problems it proposes to solve are in the vital interest of the whole country. They are matters of ordinary common sense, of business sense. The trade of this country and of the world must be done at lowest cost in keeping with the quantity and character, and therefore the country must take advantage of the possibilities of the waterways in and around New Jersey. New York and New Jersey must not antagonize each other, nor are they doing so. They must mobilize their resources for the great good of the whole country. If they grant what you seek they will be giving to the nation and to the world one of the most important elements in the world-wide demand for American commerce, American goods of all kinds. There is now a merchant marine of 1,300 ships. Don't send them across the water in ballast, but load them with the products of the South, the West and all other sections of the country. New Jersey will help; Newark has already helped by spending millions of dollars on the meadows adjacent to the bay."

U. S. Senator Joseph H. Frelinghuysen

Senator Frelinghuysen in discussing this same subject said: "New Jersey, located as it is upon the Atlantic Ocean, is distinctly a maritime State. The great problem at the present time is the question of enlarging the terminal facilities of the great transcontinental lines that cross our State and have their terminals on this side of New York Bay. To relieve the congestion, it is absolutely essential that all projects for the development of deeper waterways should be encouraged by Congress. I believe that the efforts to deepen and improve the Newark Bay, not to mention Hackensack and Passaic Rivers and adjacent waters, should receive the hearty support of the two Senators and all the Congressmen from New Jersey. Nor should the project be deemed a local one in any sense. There is an imperative demand to relieve the congestion in New York Harbor. All commercial and maritime interests, and all transcontinental trunk lines and ocean-going steamship lines as well, are deeply concerned in this proposition, for they have more at stake than has New Jersey itself."

These expressions coming from representatives of the Upper House of Congress simply go to emphasize the nation-wide value of a section whose interests are no longer confined locally.

Dr. Henry V. Walker

With relation in particular to the chemical industry Dr. Henry V. Walker, President of Maas & Waldstein Co., said: "Our plant for a number of years has been located on the Passaic River in Newark. We have enjoyed, during all these years many advantages of what we consider an ideal location, and as a demonstration of our opinion of Newark Bay we, during the war erected on its shores a plant costing upward of a million dollars for the manufacture of gun cotton, and from this plant we were able to deliver our product for export to our Allies with but a single transfer. Furthermore we have found the local authorities most liberal in their treatment of us, always willing to co-operate and aid in the development of our industry."

Jersey City has under projection a tremendous water front improvement along Newark Bay which contemplates an expenditure of approximately \$27,000,000 for the construction of piers and bulkheads, and the reclaiming of meadow lands, building of roads, etc. This work is in the hands of a joint committee of the various civic organizations and will probably take concrete form in the near future.

Stock Promotion and Potash in West Texas

TO protect the public from misrepresentation and fraud by unscrupulous promoters and sellers of stocks based on potash deposits in western Texas the United States Geological Survey states that the potash deposits there, instead of being 1,100 or even 300 feet thick, as represented by the promoters, have not yet been proved to be of workable thickness or of commercial value.

Potash Discoveries

Rich potash salts, comprising the mineral polyhalite, which were deposited in association with great thicknesses of rock salt and gypsum in "red beds," as in Germany, and, in fact, at the same time as the German deposits, have been discovered by representatives of the United States Geological Survey and the Texas University Bureau of Geology and Technology in a cooperative search, but though this discovery, which was made public early in June, is encouraging and interesting, the practical question whether the deposits are thick enough to mine, *i. e.*, whether they are worth anything, is yet to be answered.

Some years ago J. A. Udden, of the University of Texas, found traces of potash salts in brines and cuttings from a well near Spur, in Dickens County, and fragments of some potash-bearing mineral in the Miller well, southwest of Amarillo, and in a boring at Boden, 20 miles north of Amarillo. Not long after these discoveries, the United States Geological Survey, which had been analyzing brines and salts from all parts of the country, transferred its principal search for potash, under authority of Congress, to the great "red beds" region of western Texas, eastern New Mexico, western Oklahoma, and southern Kansas.

About three years ago the Texas University Bureau, in charge of Dr. Udden, joined with the Federal Survey in this search. The systematic study of the geologic history of the region and of the salt and gypsum deposits, including the physical conditions prevailing in the area when these deposits were laid down, convinced the geologists that potash salts may have been deposited somewhere in this region in commercial thickness. Over 600 feet of rock salt were precipitated through the evaporation of sea water that was impounded in shallow basins in parts of this great area, and, according to the geologists, beds of potash salt also should have been laid down in some of these basins in association with the rock salt and most probably in areas where the rock salt attained its greatest thickness, deep beneath the Staked Plains region.

Cooperation of Oil Drillers

The discovery of these beds, however, would depend, first, on drilling for oil in some area where the potash was laid down, and second, on the very doubtful chance that the potash salt, if bored through, would be noticed by the driller. Accordingly the cooperation of the companies drilling the region was requested in this search; they were asked to save samples of the drill cuttings of wells sunk in and near the salt beds and of any brines that might be found.

Most of the drillers, however, considered this work too troublesome, so that the samples of cuttings and brines submitted were relatively few and represented mainly wells drilled in the northern part of this region. During the oil boom, however, the "wildcatter" has here and there drilled a test well for oil nearer to the Staked Plains, and some cuttings from a number of

those wells have been tested by the field observer stationed by the Survey in northern Texas.

Composition of Samples

In a sample taken at depths between 2,405 and 2,425 feet from the Bryant well, in Midland County, the field observer found strong signs of potash. While samples from this well were being analyzed salt rich in potash was found in cuttings from the 1,864 foot level of the Burns No. 1 well, in eastern Dawson County. The sample of cuttings from the Bryant well, consisting of red shale, salt, mud, and pieces of polyhalite, contained, as a whole, about 6 per cent. of potash (K_2O) or 8.9 per cent. of the soluble salts. The potash probably represents a thin seam in an interval of 5 feet. The sample from the Burns well, which was obtained at a depth of about 1,864 feet, included some polyhalite and yielded about 10 per cent. of potash (K_2O).

The drillers were in search of oil, not potash, and the samples were not taken in a way to show the actual thickness of potash salts cut by the drill, so it is not yet certain whether the layer or layers containing the potash are a foot or more in thickness or less than 6 inches. The samples themselves are fragments of rock, mud, crystals of rock salt, gypsum, potash salt, etc., and are not sufficient to show the thickness of the bed.

The Burns well is about 70 miles north-northeast of the Bryant well, and the potash may have been obtained from a single stratum that extends throughout this distance, though in the intervening space, or possibly far to one side, potash may be present in much thicker beds, for neither of these wells may be in the area where potash was deposited in greatest thickness.

Still more interesting and possibly more significant indications of potash have recently been found in another well in western Texas—the River well of the A. Pitts Oil Co., about 8 miles east of Barstow, in Ward County. At this well, which is near Pecos River, about 75 miles west-southwest of the Bryant well, potash salt was found at four levels. The sample of cuttings gathered between the depths of 1,600 and 1,610 feet showed 9 per cent. of potash (K_2O), or 14.4 per cent. of K_2O in the soluble salts. The sample taken between 1,610 and 1,614 feet yielded 5.6 per cent. of potash, or 8.4 per cent. of K_2O in the soluble salts. This sample may represent matter fallen from the overlying deposit.

Another sample, taken at or near the depth of 1,645 feet, contained 4.23 per cent. of potash, or 10.5 per cent. of K_2O in the soluble salts. A fourth sample taken at a depth between 1,695 and 1,700 feet, yielded 6.29 per cent. of potash, or 11.35 per cent. of K_2O in the soluble salts, and a sample taken at a depth between 1,700 and 1,704 feet gave 2.49 per cent. of potash, or 5.74 per cent. of K_2O in the soluble salts. A sample taken at a depth of 1,875 feet contained 5.6 per cent. of potash, or 10.5 per cent. of K_2O in the soluble salts. When visited by the field observer the slush pit of this deep well contained a considerable accumulation of salt crusts, including pink potash salt. One selected fragment, weighing more than 75 grams, contained 11.5 per cent. of K_2O , and a 2-gram sample of red salt, which was carefully separated and cleaned, yielded on analysis 15.2 per cent. of K_2O .

Warning to Investors

The results of the tests of the borings from these

three wells, of which those that are farthest apart are distant from each other about 125 miles, are certainly encouraging, but the Government geologists warn the public that the conditions of drilling and sampling at all three points are so unsatisfactory that it still remains to be seen whether the beds that are rich in potash are thick enough to justify their commercial exploitation.

Considerable drilling, including wells in new areas, as well as careful examination, evidently will be necessary to determine the thickness of the potash deposits in any of the areas with the accuracy necessary for sound commercial computations. The potash content

Activated Carbonized Lignite

A development of greater significance than is attributed on first thought lies in the demonstration of the superior efficiency of decolorizing carbon made from lignite over animal bone black in sugar refining and in the decolorization of vegetable fats and oils and a wide variety of chemical and pharmaceutical products.

In the abundance and wide distribution of our fuel resources lies the explanation of our neglect of lignite and of our only recent knowledge of its commercial possibilities, a situation hastened by industrial growth in regions adjacent to lignite deposits, which were compelled to resort to their development by the prohibitive cost of more efficient fuel.

More development work as regards lignite has been done abroad because of the imperative necessity of utilization of resources at hand. One important result, aside from treatment to increase thermal efficiency, has been the demonstration of its value as raw material for a clarifying agent for which purpose the product is marketed as a proprietary commodity. Carbonized lignite was found to be more active than bone black. Treatment of the carbonized lignite, which as it comes from the retort is glassy, hard, steel-black, with a metallic ring, and with the porous structure of the original vegetable matter preserved, results in the great enhancement of the adsorptive properties. Carbonized lignite treated with boiling concentrated hydrochloric acid, washing and neutralizing with dilute ammonia and reigniting yields a product able to absorb and retain 145 volumes of chlorine gas. At the beginning of the absorption, the temperature of the carbon rises considerably and hydrochloric acid is present in the carbon at the end of the reaction.

On account of the high chlorine-absorbing property possessed by the activated lignite carbon, its value as a catalyzer in chlorinating methane has been demonstrated.

In the production of carbon tetrachloride on a commercial scale, by the chlorination of natural gas, activated carbonized lignite may serve as a very efficient catalyzing agent.

The superiority of this material in the removal of coloring matter and impurities from solutions, over bone black arises from the high carbon content and porosity of the commercial product. Bone black contains, on the average, 10 per cent. of carbon, the remainder consisting of calcium phosphate and the various other substances of which animal bones are composed. Practically only about one-half of this carbon is active because being set in against the bone skeleton, a part of the surface of the carbon particles is not exposed to the solution. Therefore, about 95 per cent. of bulk has to be handled in order to obtain about 5 per cent. of active decolorizing carbon in bone black.

of the salts must, of course, also be taken into consideration. Some other area in the "red beds" region not yet drilled, or not properly tested if drilled, is likely to contain the maximum thickness of potash deposits.

Drill cores are needed instead of the unsatisfactory samples brought up by the bailer, or, worse yet, washed up by the rotary rig without means of accurate determination of the actual thickness of the layer of potash or of its exact depth. Thorough tests with the core drill are justified by the tremendous importance to the whole United States of the discovery of commercial deposits of potash in this region—a discovery of far greater value than that of an oil pool.

The amount of bone black that must be used properly to decolorize a liquor for manufacturing refined sugar is, on the average, 100 per cent. of the weight of the dry sugar. Commercial activated carbonized lignite need be used only to the extent of 5 per cent. of the weight of dry sugar, and is capable of repeated use, before rectification, to degree not possible with bone black.

New Jersey Chemical Society at the Chemical Exposition

The New Jersey Chemical Society will maintain at Booth 57 of the Chemical Exposition a bureau for the registration of all men who make their living in chemistry in New Jersey and for all products and supplies made and used by the chemical and allied industries of that State.

Dr. Frederick D. Crane, secretary of the society, will be in charge and available to all desiring information as to the chemical resources, activities and opportunities of the State.

The New Jersey Chemical Society in this way seeks to strengthen its influence as a constructive agency in co-ordinating and reflecting chemical enterprise in its State and to show to all interested in the intensive cultivation of interest in applied chemistry what easily is possible and should be done by public-spirited chemists in all States wherein chemically controlled industries are prominent.

The Department of Justice has instituted civil action seeking to dissolve the Cement Manufacturers Protective Association on the ground that the association operates in violation of the Sherman Act. Pending a result of the petition that the defendant be enjoined from maintaining the association, a temporary injunction has been asked for.

* * *

John F. Queeny, chairman of the board, Monsanto Chemical Works, St. Louis, Mo., says that the completion of the company's new synthetic camphor plant upon which \$425,000 has been expended and which will require \$1,000,000 more, is contingent upon adequate tariff protection during the formative development of the industry.

Germany's development of synthetic camphor manufacture was checked during the war because of the inability to procure oil of turpentine, an American product. Mr. Queeny believes that unless the American industry is encouraged Germany and Japan, producing respectively the synthetic and natural camphor will be competing for the American camphor business.

Modern Equipment in Varnish Manufacture

Description of the Installation and Operation of an Improved Type of Paint Oil and Japan Drier Manufacturing Equipment at the Plant of the Tropical Paint & Oil Co., Cleveland, Ohio.

By A. P. Gloeckler

ABOUT two years ago, the Tropical Paint & Oil Co., Cleveland, Ohio, decided to investigate the possibilities of manufacturing mixing varnishes, paint oils and driers by fluid heat-transmission. In the past these paint vehicles have been manufactured over open coke fires in large copper or iron kettles, though some of the varnish manufacturers have replaced the coke fires with fuel-oil burners.

As a result of this investigation, it was decided to put up a new building and install the necessary machinery to carry out the manufacture of the mixing varnishes, paint oils and driers by fluid heat-transmission.

The new plant, Fig. 1, is a brick and concrete building, 74 x 46 feet, part of which is two stories high. The first floor is divided into four rooms, viz., the absorber room, reducing room, settling room and tank house. The second floor is used as the cooking room.



Fig. 1. Paint, Oil and Japan Drier Plant - Tropical Paint & Oil Co., Cleveland, Ohio.

Heating Plant

The heating plant consists of a 600,000 B.T.U. Parks-Cramer industrial heating equipment. The absorber, which is of the Merrill Process type, is set on a standard type dutch oven and the heat is generated by two fuel-oil burners. In this method, the circulating oil is forced through the absorber by the circulating equipment which consists of a special positive displacement rotary pump, strainer and air separator.

In passing through the absorber the circulating oil absorbs the heat generated by the burners and passes on through insulated mains to the kettles. The losses by radiation from the insulated mains leading to the apparatus where the heat is used is almost negligible.

The burners are controlled by a single-duty reverse-action temperature regulator which is operated from the cook room. The regulator operates at fifteen pounds air pressure, and can be set at any temperature from 550-600°F. The air is supplied by a small air compressor attached to the circulating pump.

To prevent overheating of the absorber as a result of any interruption to the circulation, such as would

be caused by the improper opening of the main by-pass or stoppage of the circulating pump due to failure of motor current, etc., there is attached to the fuel-oil line a differential type automatic stop valve. This valve will interrupt the supply of fuel to the burners as a result of any change in pressure between the outlet and inlet of the absorber. When closed from any cause, the valve will remain closed until circulation has been restored, after which the valve must be opened manually before the burners can again be lighted.

The circulating oil is a specially refined mineral oil, without vapor pressure or distillate up to its flash point which is 600°F.

Cooking Equipment

The cook room is 26 x 46 feet. The cooking equipment consists of four four-hundred gallon Dopp seamless oil-jacketed kettles, manufactured by the Sowers

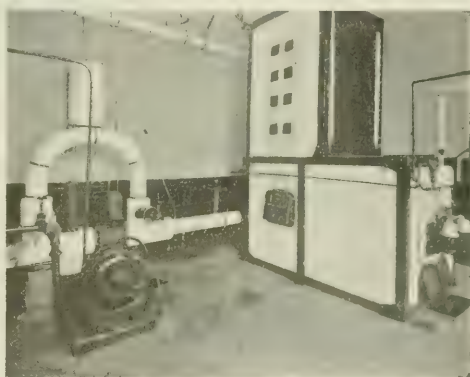


Fig. 2. View in Absorber Room, Showing Fluid Heat-Transmission Equipment.

Mfg. Company, Buffalo, N. Y. These kettles are hemispherical in shape, being 67 in. inside diameter at top and 43 in. deep. They are jacketed to within 17 in. of the top flange, having 35.6 square feet of heating surface. In order to get uniform heat distribution four oil inlets are provided at the bottom of the jacket and four oil outlets at the extreme top of the jacket.

This distribution is aided materially by the staybolts which break up the direct flow of the oil from inlet to outlet. This patented staybolt construction is one of the most valuable features of the Dopp seamless steam and oil-jacketed kettles. These staybolts are not set into the molds and cast into the shells but are formed, the same as the shells are, in the molding process.

The seamless stay-bolted construction of these kettles is of particular advantage in connection with oil heating, as oil at the temperature used in this process will find its way through seams or joints which would be perfectly tight for ordinary work. The kettles are provided with a 3-in. combination outlet and valve, so designed that the valve seat is flush with the inside bottom of the kettle, thus preventing the pocketing of material

in the bottom and permitting the direct piping of contents to the reducing tanks. (Fig. 5). Each kettle is equipped with a black iron hood and a 25-ft. stack.

Cooking

The kettles are charged through an 18 x 24-inch door in the hood. The different oils used in manufacturing are fed in through a pipe line attached to an oil meter at the outlet of a rotary pump. The inlet of the pump is attached to a branch-T, which is connected to the different oil lines leading to the storage tanks. Each kettle is equipped with a recording thermometer, which records the temperature of the batch. After a batch has reached its maximum temperature, the by-pass valve is opened and the circulating oil passes back into the system without going through the kettle.

In order that the kettle-man may know the temperature of his circulating oil, a mercury bi-recording thermometer has been placed on the instrument board next to the temperature control regulator. This thermometer records the temperature of the circulating oil at the inlet and the outlet of the absorber, the difference between the two being about 25°. After the batch has been cooked, the valve on the bottom of the kettle is opened and it passes down into the reducing tanks.

Reduction

The reducing room is the same size as the cook room and is directly below. The reducing equipment consists of four eight-hundred-gallon welded steel tanks equipped with mixers and vapor-tight covers manufactured by the Sowers Mfg. Co. The mixers consist of alternate revolving and stationary paddles, the latter preventing the different materials being carried around in a mass.

The temperature of the batches when dropped from

the jacketed cooking kettles ranges between 500 and 550°F. They are allowed to cool to about 350° F. before being reduced, the temperature being recorded by an indicating thermometer attached to each tank. The thinning liquids are metered in through a pipe line passing into the top of the tank. Each tank has a 6-inch exhaust pipe which connects into a 10-inch main exhaust line connected to a suction blower, and the fumes are exhausted through a 18-in. stack. After the batch of material has been reduced it is pumped into the settling tanks (Fig. 6), or directly to the storage tanks (Fig. 7). A meter is attached to the pipe line from the pump leading to the storage tanks, which records the gallonage.

Settling and Storage

The settling room is 21 x 26 feet. The settling tanks are of 3,300 gallons capacity. Here the paint, oils, etc., are allowed to settle until clear and then filled in drums ready for shipment.

The storage tank room is 24 x 46 ft., and contains thirty-two steel tanks each having a capacity of 750 gallons. These tanks are in two tiers around the walls. The different oils and driers are filled into packages in this room or are pumped by a battery of pumps in the pump-shed to all parts of the paint works, where they are used in the manufacture of paints.

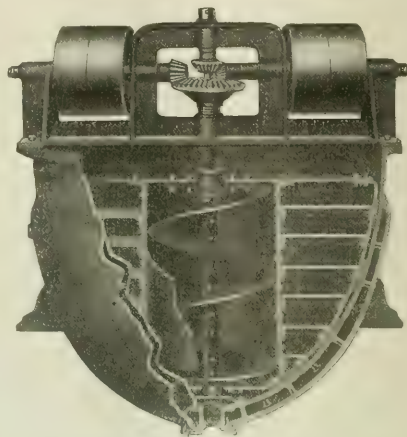


Fig. 3 Showing Construction Features of the Oil-Jacketed Varnish Kettle.



Fig. 4 The Modern Varnish Kettle, Showing the Combination of the Oil-Jacketed Kettle with Fluid Heat Transmission to Varnish Manufacture



Fig. 5 Reduction Kettles for the Transformation of the Oleo-resinous Product of the Varnish Kettle Into the Finished Product by Means of "Thinners."

Increased Efficiency

A comparison of the operation of the old coke-fired plant with this new plant shows the following:

I. Increased production with less labor, as in the old plant 150 to 200 gallons were made per batch, according to material being made; in the new plant, with from 40 to 50 per cent. less labor, 650 to 700 gallons are now made per batch.

II. Greatly improved labor conditions, as open coke

fires, hand mixing and moving the kettles on and off the fires in order to maintain an even temperature, are done away with.

III. Simplified temperature control, as a constant temperature of 500° F. has been held on a batch of material in one of the kettles for four hours with a variation of not more than 5 degrees; in the old-type plant, it would have been necessary to move the kettle on and off the coke fire a number of times.

IV. A very much lower rate for fire insurance, due to the practical elimination of fire hazard.

It is possible to make all types of paint vehicles that do not require a temperature of over 550° F., in this style of plant.



Fig. 6. Storage Room Where the Product of the Reduction Kettle Is Allowed to Settle Until Clear.

Fire Protection

A special Foamite system has been installed for protection against fire which may occur in one of the kettles or reducing tanks. This system consists of a forty-gallon Foamite engine connected with a main pipe line, with an outlet leading into each kettle or tank. This outlet line is equipped with a quick-opening gate-valve which is operated by a chain in the front of the kettle. This pipe line is shown in Fig. 4.

In case of fire the engine is started in the usual way and the valve opened on the line leading into the kettle which is on fire. As the doors on the kettle hoods are tight-fitting and also the covers on the reducing tanks, the Foamite soon extinguishes the blaze. After the fire has been extinguished the valve leading into the kettle is closed and the remaining charge in the engine is allowed to run into the sewer by opening a valve at the end of the system.

Increased Output With Less Help

While the plant has not been in operation long enough to compile definite figures and details some general comparisons can be made.

A very considerably increased production can be obtained by a smaller number of workmen, because of the fact that larger batches are made and that the amount of handling is very much reduced. In the old plant 150-200 gallons were made per batch according to the material being manufactured, whereas in the new plant with from 40-50 per cent. less labor 650-700 gallons are now made per batch.

In the matter of fuel there is a substantial net saving, in spite of the fact that the actual fuel consumed costs about 20 per cent. more than the coke used in the old-type fires. Part of saving is of course due to the same reason as the labor saving, viz., the increased size

of the batches. There are other savings, however, that are direct. In the old plant the coke fire had to be started in the morning and took from 1½ to 2 hours to obtain its full heating efficiency. From 3-4 times a day the coke fires have to be rebuilt with a consequent loss in heating efficiency. At the end of the day when the last batch has been pulled from the fire there is



Fig. 7. Tank Room Where the Finished Varnish Is Transferred to Containers for the Market.

a burning-out period ranging from 1-2 hours which represents a total loss of heating units.

In contrast to this, when the fuel oil is lighted in the absorber the circulating medium can be brought up to full heating efficiency in one hour or less and from then on during the day only such fuel as is needed to maintain the desired heat has to be consumed. When the cooking has been completed the burners are shut off and there is no further waste of fuel.

Other items of expense in the old-type plant such as unloading coke, hauling it to storage and then to the fires, removing ashes, etc., are absent entirely in the new plant.

Improved Working Conditions

The labor conditions are greatly improved, as when using open coke fires in the summer the temperature in the cook room is often very high, but in the new plant very little heat radiates into the room, for the kettles are all covered with 2-in. magnesia coverings. Hand-tiring when reducing and moving the kettles from the cooking room to the reducing room are done away with. There are no fumes in the cook room as they are all collected under hoods tight-fitted to the kettles and then carried away through exhaust stacks. In the old plant there always were traces of fumes especially when the kettles were drawn from the fire.

Temperature control is very much simplified, and this is one of the main things in paint-vehicle manufacture. A constant temperature of 500° has been held on a batch in one of the kettles for four hours with a variation of not more than 5°. In the old type plant it would have been necessary to move the kettle on and off the coke fire a number of times. The danger of over-heating a batch is reduced to a minimum by the use of the temperature control apparatus; by maintaining uniform temperature the quality of the goods is improved.

A very much lower rate of fire insurance lies in the practical elimination of fire hazard. It is possible to make all types of vehicle paints that do not require a temperature of over 550° F. in the new plant. The writer wishes here to thank Mr. A. A. Sims, superintendent of The Tropical Paint and Oil Company for his help in preparing this article for publication.

Coal-Tar Chemical Production

Coal-tar intermediates produced in the calendar year 1920 aggregated in value \$95,291,686, whereas during the same period the imports of these articles had a value of only \$751,448, or less than 1 per cent of the value of the American production.

Dyes and other finished coal-tar chemicals produced in the calendar year 1920 amounted in value to \$112,165,865, whereas the imports of these articles during the same period amounted to \$5,804,905, a little more than 5 per cent of the American production.

Furthermore, during 1920 exports of aniline dyes amounted to \$22,450,480 and exports of "all other dyes" consisting in part of synthetic dyes of coal-tar origin, amounted to \$7,373,111. It is, therefore, clear that during 1920 the domestic production of the articles enumerated in the above groups was much in excess of 60 per cent of the domestic consumption.

Although complete statistical evidence as to production is not available for any later period than the calendar year 1920, it is apparent that importation of these products has not increased during 1921 to such an extent that at the present time less than 60 per cent in value of the domestic consumption is supplied by domestic production.

English Chemists Meet with American Chemical Society

Beginning with the annual meeting of the Society of Chemical Industry of Great Britain at Montreal on August 29th, and followed by the fall meeting in New York at Columbia University of the American Chemical Society during Sept. 6-10 inclusive, is a preliminary period of the cultivation of public interest in the activities of chemists which will have concrete display at the Seventh National Exposition of the Chemical Industries at the 8th Coast Artillery Armory in the Bronx during Sept. 12-16th inclusive.

Society of Chemical Industry

The Society of Chemical Industry has five sections in Canada, *viz.*, Montreal, Ottawa, Shawinigan Falls, Toronto and Canadian, Pacific (Vancouver, B. C.). The only American section is the New York, with headquarters in New York City, of which Dr. Allen Rogers, Pratt Institute, is secretary.

In honor of its Canadian sections the presidency of the Society of Chemical Industry for the ensuing year has been accorded to Dr. R. F. Ruttan, director, department of chemistry, McGill University, Montreal, a chemist, teacher and publicist, amply qualified by capacity and popularity to head the great English technical chemical society. The induction of Dr. Ruttan into the presidency, an honor already accorded to Profs. Charles F. Chandler, Ira Remsen, Marston T. Bogert and Dr. William H. Nichols, American chemists and administrators, will be the occasion of the first meeting in Canada of the society. Accompanying the retiring president, Sir William Pope, to the Montreal meeting is a delegation of prominent English chemists, which will include in its itinerary attendance at the American Chemical Society meeting and the Chemical Exposition in New York.

After the Montreal meeting visits will be made to Shawinigan Falls and to Toronto where is now open the Canadian National Exhibition. The party will be received as guests of the American Chemical Society at Niagara Falls on Sept. 5th, whence, after visits to industrial plants at Niagara Falls, Buffalo and Syracuse, New York will be reached Sept. 7th, via Hudson

River night boat. A joint meeting of the American Chemical Society and the Society of Chemical Industry is scheduled for Thursday, P. M., Sept. 8th.

Among the visiting English chemists are: Dr. Andrew McWilliam, assistant professor of metallurgy, University of Sheffield; Capt. C. J. Goodwin, of Oscar Goodwin & Sons, consulting chemical engineers; Dr. Frederick W. Attack, chemical teacher and author; Prof. J. W. McBain, University of Bristol; C. S. Garland, rare earths specialist; Frederick W. Gamble, director, Allen & Hanbury's, Ltd.; Dr. Louis A. Jordan, member British Mission on Explosives to the Italian Government; Andrew Smith, Scotch chemist; Dr. J. P. Longstaff and E. V. Evans, respectively secretary and treasurer, Society of Chemical Industry; and Sir William Pope, retiring president. Sir William is a gas works chemist, elevated to the directorship of chemistry, University of Cambridge, and prolific in research that contributed greatly to English chemical production and Allied victory during the war.

Canadian Imports Must Be Marked with Place of Origin

Beginning December 31, 1921, all merchandise imported into Canada will be required to be marked, stamped, branded or labeled in a conspicuous place, in legible English or French words, to indicate the country of origin—that is, the country where grown or made.

It will not be a compliance with the law and regulations to brand a product with the name of the city, province, state or other division of a country, for instance, "Made in California." The statement should read "Made in the U. S. A." or "Grown in Turkey."

The words "made," "produced" or "grown" may be used to suit the circumstances. Individual packages and articles are required to be labeled, while shipping cases need not be branded.

Under the Canadian Foods and Drugs Act of 1920 food products are required to be branded with the name and address of the manufacturer. This provision became effective January 1, 1921. However, a regulation has been promulgated under the law reading as follows:

"Food and drug products shall be designated by their common names in one or other or both of the official languages. The common name of the article above referred to shall appear on the main panel of the main label, with the name and address of the manufacturer, or that of the person or firm for whom the article is manufactured."

The F. J. Stokes Machine Co., manufacturer of pharmaceutical and chemical machinery, and vacuum drying apparatus, has moved into its new plant at Tabor road and Cedar Grove Station, Phila., Pa., (Onley P. O.), which occupies $5\frac{1}{2}$ acres of ground, and is equipped with all modern facilities.

* * *

The General Asbestos Co., 58 Warren Street, New York, and the Raybestos Co., Bridgeport, Conn., have consolidated under the first mentioned name, with aggregate assets of \$9,615,000. The former company operates a plant at North Charleston, S. C., and the latter, plants at Bridgeport and Stratford, Conn., and Petersboro, Ont., all of which will be continued in operation. C. Jenkins is chairman of the board, and Sumner Simpson, president of the new organization.

The Research Chemist in the Fruit-Products Industry

H. A. Noyes, M. S.

Fellow, Mellon Institute of Industrial Research; Director of Research, The Welch Grape Juice Co.

I HERE stress some factors that engage the management of a pure food plant. Our purefood laws were promulgated and are enforced for the protection of the consumer. The average consumer, however, looks at the price per package more than at what is on the label.

Pure food laws are difficultly enforced beyond a certain point, for we have so many varieties of each fruit and berry that no exact analysis or formula can be given as the standard to which a pure food product must comply. Each year's crop is the result of seasonal conditions and in some years the same crop, grown on the same land under supposedly the same conditions, is very different from the crop grown the year previous. This gives a small latitude for the enforcement of the pure food laws and often makes it impossible for the control analyst to show positively when materials have been added by a manufacturer.

Pure food products are different today from what they were 20 years ago. Methods of handling fruit and processing are different. Application of recent results obtained in investigations of sterilization, the use of improved machinery, larger plant units and better transportation facilities make it easier to produce a higher-class product from a given material than was the case a few years ago.*

The Prejudice for the Customary

Food preserving is an art; in fact, in its inception it was a household art, and it is fair to say that some people are condemning fruit products that are purer and of higher quality than those they are accustomed to; simply because they do not look like those made by cruder methods a few years ago.

The pure food manufacturer finds that prejudice for a product that looks like what the same-named product did 20 years ago is a temptation to him to go backwards rather than forwards, *i. e.*, to cheapen his product. Cheap apples when everything else is high tempt some to put in apple base up to the quantity which can be *proved* by analyses according to the more or less crude analytical methods that we are forced to use in control-work.

It is a disappointment to the manufacturer with good intentions, who has spent considerable effort and money in developing a process including the best of sanitary methods, the minimum of heat and vacuum cooking, to have his product *at first* unfavorably received by a consuming public because it does not have the charred color and cooked taste that he has worked hard to overcome. It also is a great disappointment to have a product unfavorably received by the public because it is not highly-spiced to cover up the pomace and oxidation products present in previous products of its kind. Quality and purity products should not require the extra salesmanship of introduction that they now do.

Not many years ago our engineering and industrial schools connected with our universities developed scientific facts to the point where industry realized the worth of pure research in connection with business. This started the installation of the research worker and laboratory in many of our larger concerns. These labor-

atories in many cases have developed to the point where they have the services of the best men in the country.

Research Problems in the Fruit-Products Industry

The sugar industry was among the first food enterprises to put its processes under the direction of the chemical laboratory. The problem of putting out uniform food products of high quality is complicated. Agricultural experiment stations have been testing different varieties of fruits and have made reports from time to time on the hardness and edible qualities of different varieties.

The varieties of fruit of the best characteristics are not those generally grown for the food manufacturer. For example, the peach of high color and flavor has in the past demanded a high price in the fresh condition and the farmer has not been growing enough extra-quality peaches to supply both the fruit-stand and the preserver. This fact has been clearly shown by what the U. S. Department of Agriculture and the National Cannery Association have found it necessary to do in order to prevent inferior fruit products from being preserved and canned. Many a preserving business has flourished and then failed due to the inability of the manufacturer to obtain enough high-quality raw material to supply a normal increased demand for his products.

The public has been educated to the distinctive characteristics of a certain food product and then been unable to obtain it year after year at a reasonable price due to small crops or crop failures. This has allowed the synthetic-flavor manufacturer to start his business and befuddle the taste of the average consumer. The employment of research methods and the application of the fundamentals of science to the syntheses of organic chemicals have been so well and generally worked on that it is becoming more and more easy to isolate, and synthesize the compounds which give flavor to fruits.

Most people are fond of fruits. Almost everyone would use fruit or fruit products in quantity if he could get them at such prices that he could afford to buy them. It thus is easy to see how the time has come when the producer of synthetic fruit-flavors is an active competitor of the pure food manufacturer.

The artificial flavor manufacturer is not bothered by spring freezes or early fall frosts. Rainy weather and sunshine are almost the same to him so far as the production of his product is concerned, and the supply of his raw materials is larger than the demand for his product at any price. Many people are getting out of the habit of eating fruit products regularly, and their tastes are therefore not as distinguishing as they used to be. We fear that an apple base with an artificial berry-flavor and coloring would in many cases be thought to be the real thing. The demand for fruit products is great if the price is right.

Economic Function of the Fruit-Preserver

Food manufacturers today have a better chance than the farmer to get perishable fruits to the consumer, for the farmers' short season for shipping fresh fruit, especially berries, demands that cars, cold storage, and many other facilities be at hand and ready for his use.

When the usual shipment of fruit reaches its destination it has to be handled so quickly that only a small

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portion of the people procure it. Food manufacturers, by having a preserved product in sealed containers, which can be sold throughout the year should be able to get their product to everyone who wants it.

Basic Problems of Fruit-Preserving

We talk of freight rates; we talk of the profits of the middleman; we talk of the high cost of glassware, boxes and containers; we talk of the high cost of labor; but when all these are considered we have left out the two necessary and fundamental problems of the pure food manufacturer, viz., the obtaining of, first, an adequate supply of high-quality raw material, *i. e.*, fruit; and, second, the processing of that material in such a way that it gets to the consumer without losing its natural characteristics.

The cost of preserving fruits probably always will keep down maximum consumption but if an abundance of high-quality fruit is produced it can bring the farmer a good return providing the pure food manufacturer has worked out methods for preserving it so that it retains its natural flavor, color and bouquet. Artificial flavors that fool "some of the people all of the time" can be made, but no one can make a synthetic peach, berry, cherry, plum or grape that will fool anyone. Pure preserved fresh fruit is something that science is trying to transfer economically to the consumer by means of the container.

We have mentioned that it requires salesmanship to put out a high-class product and that many a high-class product has been unable to satisfy the market created for it.

Research Enterprise

To get at the two big problems that are confronting the pure food manufacturer, the organization with which I am associated has affiliated with the Mellon Institute of Industrial Research and thereby called into service tried methods of attack that already have proved themselves in connection with other industries. A department of research has been established whose work includes the following:

- I. Solution of problems connected with the production of high-quality fruit.
- II. Laboratory control of factory processes.
- III. Research on fruit-beverages and jams.

The production of fruit of high quality is a bigger problem than any experiment station seems to have tackled up to the present time. The research department is attempting to overcome those variations in climatic conditions which allow large crops one year and small crops another, by studying the growth of fruits of different kinds in scattered but supposedly favorable localities. All the work is organized from the problem viewpoint.

In the past, fertilization of crops has been studied through soil analyses, the analyses of plants, and yields. The plan of investigation which is being undertaken includes all these. Variations in analyses produced by fertilizer treatments, cultural practices and pruning methods are the things to which real attention is given. Tendencies towards desired characteristics are the goals desired in experimental work.

The soils of different sections of the country are being analyzed and studied in connection with variations in the fruit produced from them by different fertilizer and soil treatments. Different soils and crops of the same section are being investigated in the same way. At the present time 43 acres of grapes are under special fertilizer tests. The larger portion of this acreage is under tests where each fertilizer element is added both

separately and in combination. This gives a basis for observing plant characteristics developed under the same climatic conditions, but with different nutrition balances.

Fruit, wood, soil and plant parts are being analyzed to find out what the normal productive plant is. Fruit and wood produced in the second year of these experiments have enough different characteristics to give the research department a basis on which to assist the general grower in putting and keeping his fruit land in the maximum productive condition.

No investigator seems to have followed the nitrogen cycle in the soil in relation to desirable fruit characters and this problem is receiving extended study. During the last few years much work has been done to ascertain the constituents of food which are most beneficial to the human system. This department is giving attention at the present time to variations in the ash constituents which are in fruits and pure fruit products. Variations in soil and plant composition in relation to variations in fruit analyses have advanced to the point where a new fruit section has been started for the production of one fruit used in large quantities.

To get information on the desirable food characteristics of certain varieties of small fruit, variety testing has been undertaken on a scale that will produce enough fruit for laboratory and factory experimentation.

The research work on fruit beverages and preserved products involves the collection of information regarding the chemistry of the jelly-making constituents in their naturally-occurring variations. For example, sugar and pectin in relation to a constant acidity give a desired product but to make the same product in a year when the proportions of these constituents are different is a very active problem. Methods of preserving natural color, natural taste and appearance have caused the inauguration of about 40 lines of experimentation, including theoretical, bacteriological and chemical problems.

To have the research work ultimately of practical value and to keep the work so far done in constant contact with factory processes, the research department keeps constantly in touch with factory methods and materials. In this way the entire line of products is constantly and gradually being improved and the results of research as worked out have ready adoption in the plant.

In conclusion it may be said that only a start has been made and that start is worth while only to the extent that is laid on a broad foundation which includes the study of the fruit from the soil to the finished product.

Patent legislation continues to be held up in Congress. Meanwhile applications at the Patent Office during the past six months have exceeded all records. The congestion there is becoming more and more serious. Failure to provide additional help and salaries continues to operate against efficiency under the increased load.

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R. L. Aggassiz, president of the Calumet & Hecla Mining Co., and of the U. S. Copper Export Association, is head of the recently organized Copper and Brass Research Association, 25 Broadway, New York, which will have as its object the education of the public to the advantages of copper and brass products over substitutes whose general use received great impetus during the war. Membership will comprise producers of copper and its alloys and distributors of their products.

Floor Plan of Exhibits

Seventh National Exposition of Chemical Industries

MAIN ENTRANCE

Directory of Exhibitors

Seventh National Exposition of Chemical Industries

Eighth Coast Artillery Armory, Sept. 12-16, New York City

- 436—Abbe Engineering Co., 50 Church St., N. Y. Pulverizing and grinding machinery, ball and pebble mills, disintegrators, rotary cutters, feed mills, laboratory mills. H. F. Kleinfeldt, H. C. Russ, C. A. Beach, A. T. Beach, Jr.
- 106—Abbe, Paul O., Inc., 30 Broad St., N. Y. Crushing, cutting, grinding, mixing, pulverizing and sifting machinery. H. Sellman, J. Buckley.
- 143—Abernethy, John F., 708 Myrtle Ave., Brooklyn, N. Y. Lead burning. Chemical equipment made of lead. J. F. Abernethy, J. J. Kiernan.
- 136—Acid Proof Clay Products Co., Akron, Ohio. Chemical stoneware. N. E. Hansen, J. E. Cooper.
- 67—Ainsworth, Wm. & Sons, Denver, Colo. Analytical and assay balances. W. H. Smith.
- 722—Albany Chemical Co., Albany, N. Y. Solvents and pharmaceutical preparations. R. M. Ritter, E. S. Wright, K. G. Schoeneman, Miss Luckings.
- 839—Alberger Chemical Machinery Co., Grand Central Palace, N. Y.
- 200—Alberene Stone Co., 223 E. 23rd St., N. Y. Stone table tops for laboratories, etc. A. Y. Meeker, W. Heins, N. N. Moneyenny, Jr., F. E. Healy, W. K. Fields, E. L. Collins, R. G. Grathie.
- 128-229—Allis-Chalmers Mfg. Co., Milwaukee, Wisc. Dust collectors, pulverizers, motors, etc. A. F. Rolf, W. E. Keine, M. J. Dorian, T. Pilger, H. W. Thompson, A. J. Cooper, F. J. Geiger, O. H. Hentz, W. C. MacEwen, C. H. Paine, G. Baiz, W. O. Taylor, W. H. Wolf.
- 707—American Chemical & Mfg. Co., Cranford, N. J.
- 527—American Coal Chute Co., Newark, N. J.
- 434—American Cyanamid Co., 311 Fifth Ave., N. Y. Models of equipment used in nitrogen fixation, and samples of raw, intermediate and finished products. E. J. Franke, R. R. Stewart, F. S. Washburn, Jr., G. Thorn, A. E. Downes.
- 619—American Hard Rubber Co., 11 Mercer St., N. Y. Hard rubber pumps, pipe, fittings, tanks and utensils for handling and storing chemicals. A. M. Ackerman.
- 231—American-LaFrance Fire Engine Co., 250 W. 54th St., N. Y. Safety devices, including respirators, filter masks, protection goggles, gloves, lanterns, etc. J. W. Knoblock, A. B. Grossman, R. J. ...
- 616—American Manganese Bronze Co., Holmesburg, Philadelphia, Pa. Bronze castings and results of various acids on bronze; special literature. T. H. Addie, C. R. Spare, C. J. Bower.
- 929—American Metal Products Co., Milwaukee, Wisc.
- 742-744—American Steam Pump Co., Battle Creek, Mich. Tank, vacuum and pressure pumps, centrifugal pumps, air compressors. T. Morford, W. Oakley, R. R. Hicks, E. H. Davis.
- 435—American Steel & Wire Co., 30 Church St., N. Y. Various commercial forms of sulfate of iron, and manufactured products. C. A. Brown, H. S. Lockwood, A. S. Lutz.
- 436—American Water Softener Co., Philadelphia, Pa.
- 320-322-324—Anaconda Copper Mining Co., 25 Broadway, N. Y. Demonstration of copper smelting and refining process, finished products, with properties and application of copper to the industries. Working display "Anaconda White Lead," etc. S. Skowronski, J. A. Shady, E. Olsen.
- 624—Angel, H. Reeve, & Co., 7 Spruce St., N. Y.
- 247—Anti-Corrosion Engineering Co., 117 W. 54th St., N. Y. Apparatus for free-from-rust water treatment. A. B. Christen.
- 204—Anti-Hydro Waterproofing Co., 39 Cortlandt St., N. Y. Acid and alkali resisting cement mortars. M. W. Meyer, B. A. Meyer, Mrs. M. D. Hausling, T. Moore, B. E. Lamphear, M. E. Townsend, W. C. Kober, C. A. Brown.
- 201—Apex Chemical Co., 223 W. 33rd St., N. Y. Chemicals for the textile, leather, printing ink, rubber, fur dyeing, etc., industries. Dr. S. M. Hermann, H. Helburn, C. B. Rausenberger, H. Rothstein, H. N. Craig.
- 540—Arkell Safety Bag Co., ...
- 626—Armstrong Cork & Insulation Co., Pittsburgh, Pa. Heat insulating materials.
- 517—Arnold Hoffman & Co., Inc., ... N. Y. Oils, softeners, gums, starches, pigment colors, etc., for the industries. Electrolytic caustic soda, liquid chlorine. H. H. ... A. ... Curtis, H. P. Geier, E. Siedenbarg.
- 141—Atlantic Engineering Co., 150 Nassau St., N. Y.
- 908—Atlas Electric Devices Co., Chicago, Ill. Fadometer for ...
- 349—Atomized Products Corp., 150 Nassau St., N. Y.
- 538—Avery Rock Salt Mining Co., J. Rector St., N. Y.
- 734—Bachmeier & Co., Inc., ...
- 148—Bahnsen Co., The, ... R. E. L. Morfield, E. S. Burnett, A. P. Kramer, L. J. Calmus.
- 236-238—Bailey Meter Co., meters, boiler meters, draft recorders, etc. E. G. Bailey.
- 713—Baker & Co., Inc.

- 632—Baker, J. T. Chemical Co., Phillipsburg, N. J. General display of c. p. chemicals.
- 827—Baker, Jos., Sons & Perkins Co., Inc., 25 W. 43rd St., N. Y. Sifters and mixers for dry materials, shown in both laboratory and commercial size machines, with and without steam jackets. A. J. Vollrath, J. C. Caley, S. D. Gridley.
- 509—Barber Asphalt Paving Co., Philadelphia, Pa. Trinidad and Bermudez native lake asphalts and gilsonite, and application of products to the industries. C. N. Forrest, J. S. Miller, L. S. Greenwood, C. A. Connor, L. G. McHugh, W. H. Sutphin, E. R. Christif.
- 417-419—Barrett Co., The, 40 Rector St., N. Y. Coal tar products, prepared roofing materials, "Tarvia," etc. H. G. Sidebottom.
- 750—Bausch & Lomb Optical Co., Rochester, N. Y. Chemical, metallurgical and binocular microscopes, metallographic equipment, optical measuring instruments, colorimeters, refractometers, saccharimeters. C. L. Oswald, E. H. Anthes.
- 537—Beach-Russ Co., 50 Church St., N. Y. High vacuum pumps, rotary air compressors, heavy liquid pumps, acid pumps. C. A. Beach, H. C. Russ.
- 527—Becker, A. J., Caldwell, N. J.
- 740—Becker, Christian, Inc., 92 Reade St., N. Y. Analytical chainomatic balances, specific gravity chainomatic balances, bullion scales (2,000 ounce capacity) and torsion scales (for cream testing, grain testing and general laboratory work). W. C. Symington, A. T. Milroy, J. W. Wetz, J. W. Dunn, S. W. Hess.
- 56—Beeckley Perforating Co., Garwood, N. J. Perforated metals, tanks, agitators, kettles, etc. F. P. Huston, T. R. Harvey, T. P. Carlson.
- 517—Belle Alkali Co., Belle, W. Va.
- 207—Bethlehem Foundry & Machine Co., Bethlehem, Pa. Chemical apparatus, sulphurators, autoclaves, nitrotrators, R. E. Wilbur, H. G. Lehman, A. H. Stevens, R. H. Stevens, A. O. Hartley, G. Ettele, S. O. Solt, C. E. Volkhardt, R. W. Fluck.
- 15—Blakiston's, P. Son & Co., Philadelphia, Pa. Books on chemistry and allied sciences. W. B. Hill.
- 628—Blackmer Rotary Pump Co., 85 Murray St., N. Y. Rotary pumps for all liquids. F. P. Goertz, A. L. Rock.
- 716—Blaw-Knox Co., Pittsburgh, Pa. Forge and hammer welded steel plate work, steel forms for concrete construction, etc.
- 530—Boyer Kienle Co., Inc., 25 West Broadway, N. Y. Vegetable oils and by-products. J. R. C. Boyer, C. F. Kienle, Jr.
- 351—Bristol Co., The, Waterbury, Conn. Recording instruments for pressure, vacuum, liquid level, temperature, electricity, etc. H. L. Griggs.
- 450—British-Amer. Nickel Corp., Ltd., Ottawa, Ont., Canada. Nickel, nickel products, precious metals. R. L. Peck.
- 747—Brown, A. & F. Co., 79 Barclay St., N. Y.
- 308—Brown Instrument Co., Wayne Junction, Philadelphia, Pa. Indicating and recording instruments, pyrometers, thermometers, etc. J. D. Andrews, G. Goodman, M. J. Hess, S. G. Ketterer, V. VanVliet, M. H. Leister, J. P. Goheen, G. W. Keller.
- 413—Buckman & Pritchard, Inc., Mineral City, Fla.
- 718-720—Buffalo Foundry & Machine Co., Buffalo, N. Y.
- 825—Builders' Iron Foundry, Providence, R. I.
- 848—Burrell Technical Supply Co., Pittsburgh, Pa.
- 327-329—Calco Chemical Co., Bound Brook, N. J. Intermediates and pharmaceuticals. J. Stevenson, A. H. Sampson, R. E. Sumner, S. Klein, R. S. Bosworth, F. E. Breithut.
- 326-328—Carborundum Co., The, Perth Amboy, N. J. Carborundum refractories, including muffles, brick, retorts, currents, etc. Dr. M. L. Hartman, C. E. Hawke, A. H. Hutchings, W. L. Meek.
- 447—Carbox Co., Inc., New Orleans, La. Vegetable decolorizing carbon. Dr. H. M. Shilstone, Dr. O. L. Barneyce.
- 319—Carrier Engineering Corp., Newark, N. J. Air conditioning equipment. R. T. Treva, A. E. Stacey, Jr.
- 904—Cash, A. W., Co., Decatur, Ill. Valve specialties. P. Spence, R. H. Keith, R. C. Cory.
- 805—Celite Products Co., 11 Broadway, N. Y. "Filter-Cel" filtering medium and "Sil-O-Cel" products for heat insulation. A. W. Knight, E. S. Crosby, A. S. Elenbust, R. L. Warburton, C. J. Parsons, A. H. Fertig, P. C. Durbin.
- 735—Central Scientific Co., Chicago, Ill. Constant temperature and electrical appliances, oil and fuel testing instruments. O. T. Jones, S. J. Chama.
- 314—Chadwick Boston Lead Co., Boston, Mass.
- 505—Chapman Engineering Co., Mt. Vernon, Ohio.
- 643—Charleston Industrial Corp., Nitro, W. Va.
- 57—CHEMICAL AGE, 118 E. 2d St., Reception Booth. R. H. McCready, E. J. Mordaunt, Lloyd Lamborn, C. W. Butterworth.
- 709-711-713—Chemical Co. of America, 64 Murray St., N. Y.
- 425—Chemical Equipment Co., Chicago, Ill. Valves, centrifugal pumps, vacuum evaporators, spray systems. R. T. White, R. V. Cook, A. Wright, C. A. Murphy.
- 331—Chemical Pump & Valve Co., Perth Amboy, N. J. Centrifugal pumps, stoneware and lead valves, tanks, etc. F. A. Warter, A. B. Antisell.
- 513-515—Chirs, Antoine Co., Delawanna, N. J.
- 544—Cleveland-Cliffs Iron Co., Cleveland, Ohio. Lay-out of plant, with photographs of factory buildings. C. B. Hall, A. Farrell, Dr. E. J. Hudson.
- 14—Clipper Belt Lacer Co., Grand Rapids, Mich.
- 307—Colton, Arthur Co., Detroit, Mich. Collapsible tube filling machinery, mixers, blatt machines, counters, etc. R. L. Colton, F. X. Roellinger, B. W. Scott.
- 330—Commercial Solvents Corp., 17 E. 42nd St., N. Y. Display of "Butanal" (Butyl Alcohol), acetone, and denatured alcohol and materials manufactured from the same. P. G. Mumford, H. E. Hall, C. L. Gabriel, T. F. Carty, C. Bogin.
- 609—Contact Process Co., Buffalo, N. Y.
- 913—Cooper Hewitt Electric Co., Hoboken, N. J. Equipment and applications of ultra-violet light for various tests. M. B. Firehock, L. J. Buttolph.
- 533—Coors Porcelain Co., Golden, Colo. Chemical and scientific porcelain. H. F. Coors.
- 535—Corning Glass Works, Corning, N. Y. "Pyrex" laboratory glassware. G. W. Drake, I. B. Cary, F. Kraissel, F. F. Pfeiffer, A. S. Eggleton.
- 68—Crane Packing Co., Chicago, Ill. Flexible metallic packing. J. N. Walton, F. E. Payne, Miss B. D'Vorin.
- 335—Crane Co., Chicago, Ill.
- 138-140—Davison Chemical Co., The, Baltimore, Md. Chemicals, demonstration of silica gel and catalytic gel. E. B. Miller, Dr. W. A. Patrick, Dr. B. F. Lowledge, Dr. P. A. Davis, G. C. Connolly, F. A. Wagner, E. C. Holden, C. W. Miller, J. R. Wilson.
- 503—Davidson, M. T. Co., 154 Nassau St., N. Y. Pumps. J. Lowe, W. E. Brennan, F. O. Kompas, T. J. Rogers.
- 608-610—DeLaval Separator Co., 165 Broadway, N. Y.
- 609—Detroit Chemical Works, Detroit, Mich.
- 318—Detroit Range Boiler & Steel Barrel Co., Detroit, Mich. Bilge barrels and drums. C. C. Choate, W. B. Goddard.
- 118—Devine, J. P. Co., Buffalo, N. Y. Vacuum drying, evaporating, etc., chemical apparatus. J. P. Devine, L. W. Graves, H. W. How, A. N. Howes.
- 731—Diamond State Fibre Co., Bridgeport, Pa. Vulcanized fibre, sheets, rods, baskets, trucks, etc. C. M. Bogert, E. J. Sniffin.
- 312—Dings' Magnetic Separator Co., Milwaukee, Wisc. Magnetic tube analysis, samples of magnetic separator products. A. H. Ackerman, E. F. Oates, J. E. Randall, R. E. Mangold.
- 244-246—Distillation Industries, Inc., N. Y.
- 214-218—Dorr, Co., The, 101 Park Ave., N. Y. Thickeners, agitators, classifiers, chemical pumps, etc. D. S. McAfee, G. W. Repetti, P. M. McHugh, H. N. Spicer.
- 602—Dow Chemical Co., Midland, Mich.
- 621—Draper Mfg. Co., Cleveland, Ohio.
- 811-813—Drying Systems, Inc., Chicago, Ill. Spray-drying apparatus. J. W. Lipper, C. H. Currier.
- 500-502-504—Du Pont, E. I., de Nemours & Co., Inc., Wilmington, Del. General display of dyestuffs and their application.
- 601-603-605—Durrion Co., The, Dayton, Ohio.
- 409-411—Eagle Chemical Co., Lead City, Chicago, Ill. Lead and zinc products and working models of processes. J. R. MacGregor, H. Gates, C. E. Gilson, W. Van Berlo, H. B. Taylor, D. T. Eastman.
- 611-613—East Jersey Pipe Co., Paterson, N. J.
- 70—Economic Machinery Co., Worcester, Mass.
- 701—Economy Engineering Co., Chicago, Ill. Electric and handpower tiering machines and barrel storage racks. T. A. Duffey, L. H. Liebel.
- 539-541—Egyptian Lacquer Mfg. Co., 5 E. 40th St., N. Y. Lacquers and enamel specimens. A. D. Sopher, C. E. Hayward, C. Schlott, B. Popper, F. G. Drake.
- 634—Eimer & Amend, 3rd Ave., and 18th St., N. Y. General display of laboratory apparatus and specialties, including filter papers, glassware, viscometers, viscometers, colorimeters, ovens, stills, furnaces, etc. T. Taistra, E. Grille, F. Fischer, I. Banner, F. Shulenberger, W. R. Eimer, C. G. Amend.
- 408-410—Electro Bleaching Gas Co., 18 E. 41st St., N. Y. Liquid chlorine and samples treated with same. J. B. Duggan, S. W. Jacobs, W. J. Weed, W. A. Kennedy, G. E. Ellis, D. K. Bartlett.
- 829—Electro Chemical Supply & Engineering Co., Philadelphia, Pa. Electrolytic cell and its application. Acid proof cement and brick. F. Wedge.
- 542—Electrolytic Zinc Co., 15 Broad St., N. Y.
- 407—Elyria Enamelled Products Co., Elyria, Ohio. Vacuum stills, autoclaves, evaporating dishes, etc. W. E. Gray, Jr., M. Donauer, R. W. Smith, S. A. Smith, W. E. Gray.
- 514-516—Elmore, G. H., Philadelphia, Pa. Centrifugals. R. C. Combs.
- 339-341-343—Empire Laboratory Supply Co., 218 E. 37th St., N. Y.
- 702—Engelhard, Chas., Inc., 30 Church St., N. Y. Pyrometers, thermometers, electric furnaces, etc. R. W. Newcomb, C. W. Hubbard, D. S. Bessemer.
- 525—Everlasting Valve Co., Jersey City, N. J. Boiler valves. E. N. Corning, J. H. Allen, W. G. Wilson, S. E. Carman, D. A. Jenkins, F. L. Schultz.
- 2-3—Federal Phosphorus Co., Birmingham, Ala. Phosphoric acid and products. T. Swann, J. N. Carothers, N. Neville, L. A. Wynn.
- 130-32—Fleisher, W. L. & Co., 31 Union Square, N. Y. Air conditioning system, spray-dryer. W. L. Fleisher, A. W. Lissauer, D. L. Connelly, R. E. Keyes, S. W. Fletcher.
- 803—Fletcher Chemicals, Inc., Philadelphia, Pa. Centrifugal extractors for coke by-product and chemical plants. C. W. Schaum, L. H. Griscom, L. H. MacLaughlin.
- 59—Florasynth Laboratories, Unionport, N. Y. Synthetic organic chemicals, raw materials for perfumes, flavoring extracts and drugs. A. Katz, L. A. Rosett, C. L. Senior.
- 243—Foundation Oven Corp., N. Y.
- 309—Foxboro Co., Inc., Foxboro, Mass. Indicating and recording instruments. W. W. Patrick, C. Fuller.
- 919—Freepore Sulphur Co., 61 Broadway, N. Y.
- 244-246—Fuel Products Corp., 110 W. 40th St., N. Y.
- 851—Garrigues, Chas. F. Co., 54 Wall St., N. Y.
- 843-845—Geigy Co., 89 Barclay St., N. Y. Aniline colors, extracts, etc. with dyed specimens. W. F. Kin, W. Seenger, J. R. Garnaue, D. P. Knowland.
- 50-51 General Bakelite Co., 2 Rector St., N. Y. "Bakelite" raw materials and specimens of finished products. H. Swan, H. S. May, W. S. Gordon, C. H. Hall, V.
- 233-235—General Ceramics Co., 50 Church St., N. Y. Stoneware shapes and apparatus, also fused silica and magnesia ware. P. C. Kingsbury, H. Royer, J. F. Curran, R. S. Beecher, K. J. Peters.
- 421-423—General Chemical Co., 25 Broad St., N. Y.
- 211-213—General Electric Co., Schenectady, N. Y. Miscellaneous display of electrical features; automatic arc welding equipment.
- 315—General Filtration Co., Rochester, N. Y. Acid proof filter plates and cells. F. E. Leiby, Col. W. W. Robacher.
- 544—Georgela Lead Works, Atlanta, Ga.
- 314—Gibson & Price Co., Cleveland, Ohio.
- 206-208—Gilmorgan Pipe & Foundry Co., Lynchburg, Va.

- 302—Glens Falls Machine Works, Glens Falls, N. Y. Rotary sulphur burner. F. B. Chappell, O. J. Mills, F. S. Chaffee, F. R. Patch.
- 126—Goulds Mfg. Co., Seneca Falls, N. Y.
- 239—Graver Corp., East Chicago, Ind. Water softening equipment, water filters, storage tanks. K. W. Bartlett, J. J. Folscher.
- 205—Grinnell Co. (Dryer Division), 1 Liberty St., N. Y.
- 55—Hanovia Chemical & Mfg. Co., Newark, N. J. Quartz glassware, mercury-vapor arc lamps, etc. J. P. Rainbault, F. W. Robinson, A. L. Schwabert, C. C. Minter, J. W. Kolbert, E. Simmons.
- 518—Hardinge Co., 120 Broadway, N. Y. Ball and pebble mills. W. H. Baker, H. Hardinge, R. B. T. Kiliani, V. A. Stout, G. F. Metz, A. Crankshaw, R. S. Schultz, Jr., J. G. Parmelee.
- 313—Hauser-Stander Tank Co., Cincinnati, Ohio.
- 723—Haynes Stellite Co., Kokomo, Ind.
- 108—Hayes, Jos. W. Corp., Michigan City, Ind.
- 305—Hepworth, S. S. Co., 342 E. 32nd St., N. Y. Centrifugals.
- 413-415—Heyden Chemical Co. of America, Inc., 135 William St., N. Y. Distillation of synthetic oil of wintergreen. Chemical specialties. S. Symington, P. Furman, C. R. Mott, G. Tewes, E. W. Wall.
- 526-528—Hooker Electrochemical Co., 21 Pine St., N. Y. Display of caustic soda, bleaching powder, liquid chlorine, etc. W. H. Chamberlain, B. K. Hotchkiss, G. F. Reale, W. J. Smith.
- 314—Hoyt Metal Co., St. Louis, Mo.
- 724-726—Huff Electrostatic Separator Co., Arlington, Mass. Electrostatic separators in operation, also graphite products. W. E. McKee, C. D. Butage, Jr.
- 114—Hungerford, U. T., Brass & Copper Co., 80 Lafayette St., N. Y. Specimens of brass, copper, etc., manufactured articles, screen cloth, tubing, etc. J. J. Dillon, F. A. Kappelmann, J. W. Watt, J. Parker.
- 812—Hunter Dry Kilm Co., Indianapolis, Ind. Samples and papers. Hunter, O. M. Kagsdale, A. B. Stoner.
- 510—Huyck, F. C., & Sons, Albany, N. Y. Filter cloth. Dr. E. A. Ross.
- 108—Huyette, Paul B. Co., Inc., Philadelphia, Pa. Combustion appliances, recorders, gauges, steam traps, etc. A. F. Buttner, H. Cole, W. C. Edgar, P. C. Huyette, P. Wood.
- 912—Illinois Zinc Co., 280 Broadway, N. Y. Zinc shingles and sheets. E. S. Gellatly, H. Mellor, A. C. Liebert, Miss E. S. Rodman.
- 134—Industrial Filtration Corp., 115 Broadway, N. Y.
- 604—Innis-Spaul & Co., 46 Cliff St., N. Y. Industrial Chemicals. E. H. Manahan, H. G. Mackelcan, C. L. Speiden.
- 728—International Carbon Products Co., Arlington, Mass.
- 62-63—International Copperage Co., Niagara Falls, N. Y. Barrels. B. E. Cuthbert, E. H. Kattman.
- 342-344—International Nickel Co., 67 Wall St., N. Y. Nickel and monel metal in various fabricated forms. F. H. Waycott.
- 538—International Salt Co., Scranton, Pa. Salt. W. T. Chisholm, H. J. Osborn, G. A. Walter.
- 722—International Smelting Co., Perth Amboy, N. J.
- 806—Irving Iron Works, Long Island City, N. Y. Water distilling equipment. P. L. Price, W. E. Irving, J. M. Madden, H. H. Schmidt, W. H. Bunker, W. H. Roope.
- 694—Isco Bantz Co., Inc., 46 Cliff St., N. Y.
- 694—Isco Chemical Co., Inc., 46 Cliff St., N. Y.
- 323—Jewell Polar Co., Chicago, Ill. Water distilling equipment. A. C. Jewell, J. H. Needler, R. E. Henry, C. Munson.
- 920—K. B. Pulverizer Co., 92 Lafayette St., N. Y. Powdered-coal machine. A. J. Barnehl, Jr., E. H. Brown, D. L. Braine, J. K. Blum.
- 837—Kellogg, M. W. Co., Inc., 90 West St., N. Y.
- 623—Kenart Synthetic Products Co., Chicago, Ill.
- 836—Kennedy Valve Mfg. Co., Elmira, N. Y. Valves. J. S. Hanlon.
- 735—Kewanee Mfg. Co., Kewanee, Wis.
- 833—Kiefer Kari Machine Co., Cincinnati, Ohio. Bottle-filling machines, etc. E. E. Finch, A. J. Sterling, M. C. Finn.
- 725-727-729—Klipstein, A. & Co., 694 Greenwich St., N. Y.
- 721—Knight, Maurice A., East Akron, Ohio. Miscellaneous display of acid-proof chemical stoneware for various industries. M. A. Knight, C. Dennison, S. J. Baril, G. G. Urquhart, P. Sawyer.
- 844—Koppers Co., The, Pittsburgh, Pa. By-product coke ovens. C. A. Meissner, D. E. Price.
- 350—Koppers Products Co., Pittsburgh, Pa.
- 823—Koven, L. O. & Bro., Jersey City, N. J.
- 215—Lake Erie Chemical Works, Nela Park, Cleveland, Ohio. Tungsten products. W. S. Mumford.
- 807-809—Lamie Chemical Co., Huntington, W. Va.
- 316—Lead Lined Iron Pipe Co., Wakefield, Mass. Pipe, valves, fittings, etc. D. H. Regan, H. F. Peck, T. E. Dwyer, J. C. Huestis.
- 337—Leeds & Northrup Co., Philadelphia, Pa. Pyrometers and electrical instruments. O. Brown, C. R. Carr, F. H. Day, G. H. English, E. B. Estabrook, E. A. Keeler, R. D. Milner, A. M. Redding, G. W. Tall, P. H. Taylor.
- 918—LeFranc Chlorozene Works, Inc., Brooklyn, N. Y.
- 65—Lewis, Green, McAdams & Knowland, Cambridge, Mass. Engineering, dryer demonstration. R. G. Knowland, J. H. Holton.
- 324—Liberty By-Products Works, Hawthorne, N. J. Chemicals, oils, soaps. E. J. Zillesen, W. H. Zillesen.
- 696—Liquid Carbonic Co., Chicago, Ill. Carbon dioxide. C. S. Wheaton, W. L. Greiner, F. D. Hall.
- 345-347—Little, Arthur D. Inc., Cambridge, Mass.
- 931—Lungmotor Co., Boston, Mass.
- 606—Lunkenheimer Co., The, Cincinnati, Ohio. Valves. W. A. Reynolds, F. R. Heyath, P. Smith, H. Burger.
- 17-18—Luzerne Rubber Co., Trenton, N. J. Hard rubber specialties. H. E. Case, R. C. Forquhar.
- 650—Maas & Walstein Co., 92 William St., N. Y. Lacquers, enamels, and leather solutions. H. C. Flanigan, J. A. Weiss, S. L. Dickinson, H. F. Maynard.
- 714—Magna Metal Corp., N. Y. City.
- 301—Magnesia Association of America, Philadelphia, Pa.
- 733—Manhattan Rubber Co., Passaic, N. J.
- 736-738—Mathieson Alkali Works, Inc., 25 W. 43rd St., N. Y. Soda ash, bleaching powder, liquid chlorine, etc. J. A. Kienle, J. W. Boyer, B. T. Brooks, K. M. Mabey, J. H. McMahon, F. E. Renth, J. A. Ross, W. D. Marshall, R. J. Quinn, R. C. Staples, L. R. Yancey, J. B. Peake, R. A. McMichael, G. N. Davis.
- 106—Mead & Co., Detroit, Mich. Grinding and pulverizing mills. P. O. Abbe.
- 600—Merck & Co., 45 Park Place, N. Y. Reagents and medicinal chemicals.
- 519—Merrill Co., The, San Francisco, Cal.
- 542—Metals Disintegrating Co., 15 Broad St., N. Y. Zinc, lead, and tin dust, etc. S. G. Schatzberg, D. A. Morris, E. J. Hall.
- 411—Midland Chemical Co., Chicago, Ill.
- 848—Mine Safety Appliances Co., Pittsburgh, Pa. Gas masks, etc. G. H. Burrell, J. L. Lehman, H. J. Segrave.
- 523—Mineral Point Zinc Co., New York City.
- 933—Mojonier Bros. Co., Chicago, Ill. Moisture tester. T. Wuestner, H. O. Bauer.
- 4-5—Monarch Mfg. Works, Inc., Philadelphia, Pa.
- 227—Mono Corp. of America, 25 West Broadway, N. Y. City. Reagents, chemicals, etc. F. D. Hanson, A. Saunders.
- 314—Monal Metal Products Co., Bayonne, N. J.
- 712—Monsanto Chemical Works, St. Louis, Mo. Medicinal chemicals and dye intermediates. G. DuBois, E. M. Queeny, W. S. Goff, A. B. Portmann, F. L. McCartney.
- 639—Morris Chain Co., Ithaca, N. Y.
- 151—Moto-Meter Co., Inc., Long Island City, N. Y. Temperature indicators. J. C. Elverson, R. Wilson, F. W. Gettler, W. Beyer, A. Rappuhn.
- 506—Mott, J. L., Iron Works, 118 5th Ave., N. Y. Kettles, stills, etc. J. J. Blumore, T. H. Blackmore.
- 607—Multi Metal Co., 231 W. 19th St., N. Y. Wire cloth. S. Stern, F. Stern, S. Pullman.
- 219—Nash Engineering Co., South Norwalk, Conn. Compressors, pumps, etc. C. C. Jennings, R. H. Carpenter, H. M. Wylie, G. B. Wright.
- 92—Nassau Valve & Pump Co., Rockville Centre, L. I., N. Y. Acid resisting valves, centrifugal pumps. A. T. Hanvick, C. Schmidt, E. M. J. Figel, B. W. Dezelott.
- 412-414-416—National Aniline & Chemical Co., Inc., 21 Burling Slip, N. Y. Display representing progress made in development of the industry and the intermediates of all dye-making, together with samples of American made goods colored with "National" dyes. Dr. L. J. Matos, S. W. Wood, W. H. Williard, E. O. Ellsworth, W. R. Moorehouse.
- 847-849—National Binding Machine Co., 260 West St., N. Y. Container sealing machines. T. Gautier, A. E. Rideout, W. D. Kimball, M. McFaul.
- 66—National Filter Cloth & Weaving Co., Brooklyn, N. Y.
- 23-24—National Gum & Mica Co., 12 West End Ave., N. Y. Glues, gums. A. A. Newman, E. J. Cohen, F. K. Greenwald, N. A. McManus.
- 745—National Lime Association, Washington, D. C. Model lime plant. M. E. Holmes.
- 642-644-646—National Research Council, Washington, D. C. Economic development and national defense. H. E. Howe, H. C. Kimberly.
- 810—National Rosin Oil & Size Co., 90 West St., N. Y. "Pine Tree" rosin oil, varnishes, turpentine, and pitches. R. Bering.
- 346—Newark Wire Cloth Co., Newark, N. J. Wire cloth, filter cloth, "micron" meter materials. F. J. Kutz, J. C. Campbell, A. A. Campbell, J. C. Campbell.
- 625—New Brunswick Chemical Co., Newark, N. J.
- 100—New England Tank & Tower Co., Everett, Mass. Agitator devices. A. E. Hall, G. E. Hall, C. Pennucci, W. O. Chace.
- 521-523—New Jersey Zinc Co., 160 Front St., N. Y.
- 14—New Method Utilities Co., Newark, N. J. Refrigeration. E. G. Campbell, B. K. Nagel, H. A. Lecue, E. G. Campbell, R. van Duzend.
- 706-708-710—Newport Chemical Works, Passaic, N. J. Dyestuff process. Mr. L. W. McLean.
- 928—New York Central Iron Works Co., Inc. Hagerstown, Md. Photos of products. P. G. Knapp, C. H. Olson.
- 802—New York Continental Jewell Filtration Co., Nutley, N. J. Filtration models. A. M. Crane, E. K. Sorenson, D. C. Waldman, A. L. Schiller.
- 408—Niagara Alkali Co., Niagara Falls, N. Y.
- 404—Niagara Electrochemical Co., Niagara Falls, N. Y.
- 422—Nichols Copper Co., 25 Broad St., N. Y.
- 738—Nitrogen Corp., Providence, N. J.
- 494—Norwalk Iron Works Co., South Norwalk, Conn. Oxygen compressors. A. R. Betts, E. H. Hildebrand.
- 524—Oberrmayer & Co., Pittsburgh, Pa. Furnace cement. E. D. Frohman, F. P. Bullion, H. E. Beckman, J. M. Hildebrand, W. R. Cummings.
- 321—Oliver Continuous Filter Co., San Francisco, Cal. Filters. H. A. Morrison, C. T. Eastman, C. W. Moore, J. W. Knapp.
- 228—Paio Co., 153 W. 23rd St., N. Y. Laboratory supplies.
- 536—Parks-Cramer Co., Boston, Mass. Heat and oil circulation systems, humidifiers. A. B. McKennie, T. Francis, S. H. Caldwell, J. W. F. MacDonald, A. W. Thompson, F. Bell, Jr.
- 715-717—Pennsylvania Salt Mfg. Co., Philadelphia, Pa.
- 325—Permutit Co., 40 Fourth Ave., N. Y. Water softening and filtering equipment. A. T. Smith, R. W. Epplie, J. S. Schindler, F. B. Reed.
- 61—Perry & Webster, Inc., 31 Union Square, N. Y.
- 309—Perth Amboy Chemical Co., Perth Amboy, N. J.
- 719—Pfaudler Co., Rochester, N. Y. Mixers, tanks and varied glass-lined equipment. R. B. Kilmer, J. A. Cowles, P. S. Barnes, F. D. Bresnan, T. D. Brown.
- 237—Philadelphia Drying Machinery Co., Philadelphia, Pa. Drying machinery. W. W. Sibson, E. K. Moore, C. H. Reimann, S. Watson.
- 703—Philadelphia Quartz Co., Philadelphia, Pa. Silicate of soda. E. C. Buxton, W. H. Buxton, J. W. Moore.
- 54—Pittsburgh Des Moines Steel Co., Pittsburgh, Pa.
- 230-232—Pneumator Co., 15 Park Row, N. Y. Gauges for measuring stored liquids. G. Cornett, H. S. Parks, W. Thomas, H. L. Snider.
- 21-22—Potdevin Machine Co., Brooklyn, N. Y. Gumming and label pasting machinery. A. M. Schmidt, C. Schaefer, A. D. Chabourne.
- 705—Power Specialty Co., 111 Broadway, N. Y. Superheaters. A. Bradley, R. H. Wyld, P. W. Foster, Jr.

- 512—Powhatan Mining Co., Woodlawn, Baltimore, Md. Asbestos, from mine to manufactured product. F. A. Mett, F. Mett.
- 134—Precision Instrument Co., Newark, N. J. Boiler and gas plant specialties. L. D. Vorce, E. C. Rack, R. Hooper, R. H. Tighe.
- 220-224-226—Proctor & Schwartz, Philadelphia, Pa. Dryers. E. B. Ayres, H. S. Landell, D. D. Hollenbaugh, A. O. Hurxthal, Mrs. A. E. Reiter.
- 537—Provost Engineering Co., 50 Church St., N. Y. Mixers, kneading machines. H. F. Kleinfeld, H. C. Russ, C. A. Beach, A. T. Beach, Jr.
- 58—Pyroelectric Instrument Co., Trenton, N. J. Electrical precision instruments. W. C. Harter, H. L. Saums.
- 620—Quigley Furnace Specialty Co., 26 Portland St., N. Y. High temperature cement and brick. J. H. McPadden, F. W. Reisman, W. H. Gaylord, Jr., W. A. Toohill, C. C. Gautzman.
- 320-322-324—Raritan Copper Works, Perth Amboy, N. J. Copper refining. S. Skowronski, J. A. Dowdy.
- 534—Raymond Bros. Impact Pulverizer Co., Chicago, Ill. Roller mills, pulverizers, etc. C. M. Lauritzen, W. M. Cook, J. Crites, S. B. Kanowitz.
- 314—Raymond Lead Works, Chicago, Ill.
- 52—Read Machinery Co., York, Pa. Mixing machinery. D. D. Strite.
- 210—Refinite Co., The, Omaha, Neb.
- 106—Reliance Gauge Column Co., Cleveland, Ohio.
- 209—Rhodia Chemical Co., 89 Fulton St., N. Y. Medicinal, photographic and technical chemicals. Dr. Max Mueller, J. A. Buchler, Dr. A. Zimmerli, C. F. Kelly, Dr. P. P. Hickerson, Dr. R. C. Lyon, A. C. Robertson.
- 314—Robertson, Jas., Lead Works, Baltimore, Md.
- 400-501—Roessler & Haselacher Chemical Co., 709 Sixth Ave., N. Y. Industrial chemicals. S. Temple, M. S. Stewart, T. V. Ainslie, Dr. F. Abegg, C. S. Williams.
- 13—Roto Co., Hartford, Conn.
- 69—Ruggles-Coles Engineering Co., 120 Broadway, N. Y. Drying machinery. F. E. Finch, J. K. Towers and W. H. Glomb.
- 835—Salmon Falls Mfg. Co., Boston, Mass. "Toron" treatment for auto tire construction. R. T. Lyman, A. R. Atwater, T. G. Sullivan, W. B. Pratt, G. M. Parker.
- 142-144—Sandoz Chemical Works, Inc., 233 Water St., N. Y. Aniline dyes.
- 640—Sandusky Cooperage & Lumber Co., Toledo, Ohio. Barrels. H. R. Huntington, P. Gaylord, A. O. Theobald, D. A. Lingel.
- 332—Sarco Co., Woolworth Bldg., N. Y. Temperature regulators, and their use in the chemical industries demonstrated. Sarco steam traps, radiator traps, blast traps, recording gas calorimeters and CO₂ recorders. C. Wells, E. J. Ritchie.
- 635—Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y. Thermometers, gauges, etc. F. Undetsch, A. E. Campbell, H. V. Carlier, J. L. Schipper.
- 150—Schutte & Koerting Co., Philadelphia, Pa. Jet condensers, oil heaters and coolers, spray nozzles, etc. C. H. Kimberly, J. J. Glessman, H. W. Philbrook, C. T. Keet.
- 817—Schwartz Sectional System, Indianapolis, Ind. Sectional filing cabinets for laboratories. M. P. Schwartz.
- 912—Schwenk Carboy Tilter Co., Brooklyn, N. Y.
- 735—Scientific Equipment Co., 70 Fifth Ave., N. Y. Laboratory apparatus. J. M. Roberts, S. L. Redman, A. B. Carter, C. G. Campbell, O. T. Louis, C. R. Res, E. Bretwieser, J. R. Fisher, T. Fuchs, Jr., A. Von Hovelting.
- 304—Scott, Ernest & Co., Fall River, Mass. Factory waste liquor reclamation processes. H. Austin, R. W. MacGregor, C. E. Bradley.
- 420—Semet-Solvay Co., Syracuse, N. Y. Coke oven model; calcium chloride in its various applications, and other products.
- 433—Seydel Mfg. Co., Jersey City, N. J. Benzoic acid, medicinal chemicals, fur dyes, E. G. Smith.
- 10—Seymour & Peck Co., Chicago, Ill. Sift-proof wooden drums. B. Arnold.
- 436—Sharples Specialty Co., Philadelphia, Pa.
- 336-338—Sherwin-Williams Co., Cleveland, Ohio. Paints, varnishes, dyes, chemicals, colors, pigments, coal tar products, insecticides, etc. A. W. Stendel, J. O. Hasson, L. D. Walker, A. J. Binder, B. N. Van Cleave, M. K. Barrett.
- 842-844-846—Shriver, T. & Co., Harrison, N. J. Filter presses. R. E. Perry, E. C. Allford.
- 138-140—Silica Gel Corp., The, Baltimore, Md.
- 700-571—Sly, W. Mfg. Co., Cleveland, Ohio. Pneumatic conveying and separating apparatus. F. A. Ebeling, E. J. Moore, M. M. Lowrie, D. E. Hadley.
- 903-905—Snyderbina Corp., Newark, N. J. Patent paper drums and barrels. C. Ashmun, O. Duryea.
- 424—Solvay Process Co., Syracuse, N. Y. Alkali products and by-products. W. C. Scott, J. Cooper, W. H. C. Grimes, G. F. Kimber, R. C. Werner.
- 639—Southern Cotton Oil Co., 120 Broadway, N. Y. Cotton seed oil by-products. W. F. Fisk, P. Brendel, G. J. Drewes.
- 334—Sowers Mfg. Co., Buffalo, N. Y. Dopp seamless steam and oil jacketed apparatus, soap crutcher, A. E. Howlett, R. Bellows, A. M. Kuhns, G. G. Urquhart, C. E. Brown, R. C. Bogges.
- 1—Stanley, W. W., 30 Church St., N. Y. Filter cloths and filter press sacks. W. A. Eisele, A. R. Peer, W. W. Stanley, J. E. Reilly.
- 328—Star Corrugated Box Co., Inc., 372 South St., N. Y. Corrugated fibre cases. F. S. Oppenheim.
- 494—Stein-Hall & Co., Inc., 61 Broadway, N. Y.
- 618—Stimpson Equipment Co., Salt Lake City, Utah. Vibrating machine and crusher. C. W. Stimpson, C. Clark, J. A. Lane, G. E. Phillips.
- 921—Stuart & Peterson Co., Burlington, N. J. Vacuum pans, evaporating kettles, etc. H. E. Jacoby, F. P. Karns.
- 730-732—Sturtevant Mill Co., Boston, Mass.
- 629—Sullivan Machinery Co., Chicago, Ill. Air lift and displacement pumps. L. R. Chadwick, J. Oliphant, L. E. Gilbert.
- 612—Swenson Evaporator Co., Chicago, Ill. Evaporators. F. M. DeBrens, F. B. Sadtler, P. H. Appell, G. G. Urquhart, F. F. Mackentepe.
- 440—Standard Oil Co. of N. J. (Chem. Prod. Div.), 26 Broadway, N. Y.
- 638—Star Box & Lumber Co., Inc., 81 Tompkins St., N. Y.
- 531—Tagliabue, C. J., Mfg. Co., Brooklyn, N. Y. Controllers, thermometers, etc. L. C. Irwin, T. Dougherty, V. Wichum, W. W. White, A. Traudt.
- 508—Takamine Laboratory, Inc., 13 Dutch St., N. Y.
- 578—Tanner, Chas. S., Co., Providence, R. I.
- 547—Taylor Instrument Companies, Rochester, N. Y.
- 300-401—Technical Products Co., Inc., 501 Fifth Ave., N. Y.
- 403-405—Texas Gulf Sulphur Co., 41 E. 42nd St., N. Y.
- 338—Thermal Syndicate, Ltd., 350 Madison Ave., N. Y. Vitreosil laboratory ware, new c. p. still. W. W. Winslip, S. L. Tyler, W. E. Strevig, F. A. Wenman.
- 615—Thermo Electric Instrument Co., Newark, N. J. Laboratory ovens, incubators and water baths. R. B. Freas, E. G. Price.
- 910—Thwing Instrument Co., Philadelphia, Pa. Pyrometers, humidimeters, etc. E. J. Albert, H. K. Walton, J. H. Torrey, J. H. Houghton.
- 427—Titanium Alloy Mfg. Co., Niagara Falls, N. Y.
- 429—Titanium Pigments Co., Inc., Niagara Falls, N. Y.
- 428-430-432—Tolhurst Machine Works, Troy, N. Y. Centrifugal extractors. W. C. Dutton, J. S. Gage, T. M. Stuart, T. A. Bryson, R. K. Cheney.
- 625-627—Tower Mfg. Co., Inc., 326 Broadway, N. Y. Dyestuffs and chemicals. F. G. Erskine, A. G. Brunier, A. H. Jonas.
- 543-545—Tyler, W. S., Co., Cleveland, Ohio. Wire screens.
- 60—Uehling Instrument Co., 71 Broadway, N. Y. Fuel economy apparatus, recorders, indicators, etc. F. F. Uehling, C. C. Phelps, C. J. Schmid, R. E. Terhune, H. D. Thomas, F. D. Borgia, W. J. Reilly.
- 739-741—Union Steam Pump Co., Battle Creek, Mich. Steam and power drive pumps.
- 614—Union Sulphur Co., 32 Rector St., N. Y. Reception booth. W. N. Wilkinson, W. M. P. Taylor.
- 120—United Filters Corp., 65 Broadway, N. Y. Sweetland filters, filter presses, etc. R. E. Campbell, E. J. Sweetland, L. D. Thompson, C. H. Stanley.
- 927—United Hammer Co., Boston, Mass. Iron pulverizing hammers. H. Parsons.
- 314—United Lead Co., 111 Broadway, N. Y. Lead lined pipe, tubing, acid pumps, etc. G. H. Checkley, J. W. Spotten, W. J. Donnan, C. L. Meyer, C. R. Andrews, H. Hempel, H. Freiherr.
- 314—United Lead Co. (Tatham Bros. Works), Philadelphia, Pa.
- 314—United Lead Co. of Cincinnati, Cincinnati, Ohio.
- 314—United Lined Tube & Valve Co., New York.
- 324—United Metals Selling Co., N. Y.
- 310—U. S. Cast Iron Pipe & Foundry Co., Philadelphia, Pa. Pipe and castings. H. A. Hoffer, J. C. Capron, C. D. Donaldson.
- 522—U. S. Industrial Alcohol Co., 27 William St., N. Y. "Alcohol" and industrial alcohols. B. R. Tunison.
- 529—U. S. Industrial Chemical Co., 27 William St., N. Y. About 40 new chemical products, iodines, ethyl ether, ethyl alcohol, etc. B. R. Tunison.
- 617—U. S. Stoneware Co., Akron, Ohio. Acid proof stoneware. F. S. Wills, J. Chamberlain, G. M. Wills.
- 748—Valley Iron Works, Williamsport, Pa.
- 241—Valley Rotary Filter Press, Bay City, Mich. Filters. H. A. Vallee, A. Vallee.
- 25-26—Van Nostrand, D. Co., 8 Warren St., N. Y. Books on pure and applied chemistry, featuring recent publications. E. M. Crane, P. G. Healy, A. G. Heany.
- 622—Vitreous Enameling Co., Cleveland, Ohio. Enamelled pans and trays for dryers, etc. H. Warman, C. E. Bullard.
- 804—Voland & Sons, Inc., New Rochelle, N. Y. Precision balances.
- 53—Wailles Dove-Hermiston Corp., 17 Battery Place, N. Y.
- 647—Wallace, J. H. & Co., Inc., 5 Beekman St., N. Y. Pine stump utilization for paper pulp, turpentine, etc. F. E. Greenwood, W. F. Burleigh, R. H. Stevens.
- 303-202—Wallace & Tiernan Co., Inc., Newark, N. J. Chlorine control equipment for water sterilization, etc. M. F. Tiernan, W. I. Orchard, L. H. Goebel, R. V. Donnelly, R. V. Henkel, G. D. Peet, Dr. J. C. Baker.
- 717—Wedge Mechanical Furnace Works, Philadelphia, Pa. Roasting furnaces. L. H. Webb.
- 801—Westinghouse Electric & Mfg. Co., Pittsburgh, Pa. Control systems for steel-treating furnaces, etc. G. H. Jaspert, C. B. Gibson, C. G. Schluenderberg.
- 225—Wheeler, C. H., Mfg. Co., Philadelphia, Pa. High vacuum apparatus. G. L. Kothny, J. Dobson, C. Lang, J. J. Mullan.
- 549-548—Wheeler Condenser & Engineering Co., Carteret, N. J. Pumps, evaporators, cooling towers, etc. Messrs. Kretzmer, Schubert, Chapin, Speer, Ervin.
- 704—Whitall-Tatum Co., 46 Barclay St., N. Y.
- 6-7—Whitlock Oil Pipe Co., Hartford, Conn. Coils and bends, solvent recovery heaters and coolers, etc. W. A. Evans, C. J. Babcock, F. J. Brengel, W. C. Beckley, H. J. C. Anderson.
- 145—Will Corp., Rochester, N. Y. Chemical, bacteriological and biological equipment, etc. R. T. Will, A. W. Mayer, W. E. Dalton.
- 19-20—Wilson Goggles, Inc. Safety goggles, respirators, etc. T. A. Wilson, F. M. Rockwell.
- 339—Winner Co., 30 Church St., N. Y. Steam traps and regulators. A. A. Smith, T. W. Monahan, R. Fruisen, F. L. Valliere.
- 9—Winslow & Co., Portland, Me. Acid resisting brick. E. H. Winslow.
- 828-830-832—Wolf, Jacques & Co., Passaic, N. J. Colors for textile printing; gums, oils, etc. S. E. Tyler, Jr.
- 249-242—Worthington Pump & Machinery Corp., 115 Broadway, N. Y. Pumping and auxiliary equipment.
- 732—Yale & Towne Mfg. Co., Stamford, Conn. Trucks and trailers. E. A. Smith, C. F. Gies.
- 815—Young Bros. Co., Detroit, Mich.
- 828—Zavon Co., Inc., Brooklyn, N. Y.
- 110—Zeller Lacquer Mfg. Co., Inc., 342 Madison Ave., N. Y. Lacquers, bronzes, solvents, etc. Messrs. Hugo, Richard and Zeller.

Personal Items

Dr. P. P. Claxton, recently United States Commissioner of Education, has accepted the provostship of the University of Alabama.

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C. A. Carlton, formerly chief chemist Avalon Rubber Co., Akron, Ohio, is now factory manager Duplex Tire and Rubber Co., Joplin, Mo.

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Allen S. Richardson, a former du Pont man at Experiment Station, N. J., is now director of research, Procter & Gamble Co., Ivorydale, Ohio.

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William O. Hadley, Jr., assistant chief chemist of the Chemical Research Company, Lynn, Mass., has been placed in charge of the tanning trade department of the company.

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James Minto, formerly dye master of the Rosemont Dye Works, Woonsocket, R. I., has accepted a similar position with the Franklin Process Company, Providence, R. I.

* * *

George M. Greene for the past 17 years with Colgate & Co., Jersey City, N. J., has resigned to become a member of the technical staff of the Lever Bros. Co., Cambridge, Mass.

* * *

H. E. Mecredy, formerly assistant superintendent of the Hopewell plant of the DuPont Chemical Co., is now associated with Vaughan, Inc., Shawsville, Va., as general superintendent.

* * *

A. P. Gloeckler has severed his connection with the Tropical Paint and Oil Co., Cleveland, Ohio, to become superintendent of the paint department of the Acorn Refining Co., Cleveland, Ohio.

* * *

Herbert Sieck, superintendent of the Chicago plant of the American Coconut Butter Co., 297 Fourth Avenue, New York, has resigned to become associated with Sieck & Drucker, Inc., Chicago, Ill.

* * *

Dr. Joseph W. Mayer, chief research and analytical chemist, Louis K. Liggett & Co., New York, has been appointed professor of analytical and pharmaceutical chemistry, Brooklyn College of Pharmacy.

* * *

Dr. Maurice L. Dolt, formerly research chemist at American Cotton Oil Co., Chicago, Ill., is now in charge of food-colors and pharmaceutical manufacture for the Calco Chemical Co., Bound Brook, N. J.

* * *

Max Y. Seaton, formerly in charge of the oxychloride research division of the Dow Chemical Co., Midland, Mich., is now in charge of research and production of the National Kellastone Co., Chicago, Ill.

* * *

Philip B. Terry, formerly development chemical engineer at the Jackson Laboratory, Deepwater Point, N. J., of E. I. du Pont de Nemours & Co., is now connected with the Spaulding-Moss Co., Boston, Mass.

* * *

Frank Kay, formerly with Weisenthal & Co., chemicals, 145 West Forty-fifth street, New York, is now manager of the heavy chemical department of the Branscombe Chemical Co., 30 Church street, New York.

* * *

Howard W. Ambruster, long identified as chemical

engineer, salesman and manufacturer, with the heavy chemical trade, has established an office at 261 Broadway, New York, for the purchase and sale of chemicals and dyestuffs.

* * *

Joseph C. Alonzo, formerly chief chemist and assistant superintendent Campbell Paint and Varnish Co., the St. Louis, Mo., branch of the Glidden Co., is in charge of the new plant of the Towns Paint Co., Inc., Buffalo, N. Y.

* * *

Dr. Edward C. Worden of Milburn, N. J., sailed September 3 on the Olympic for a short business trip to England, France and Germany in connection with the development of some new industrial uses of the cellulose esters.

* * *

Donald D. Smyth, instructor in economic geology at Cornell University, has accepted a position as geologist with the Cerro de Pasco Copper Corporation, 15 Broad street, New York, which has extensive mineral deposits in Peru.

* * *

C. S. Bryan, recently manager of the Charleston Chemical Co., Charleston, S. C., and formerly superintendent and research chemist with the Virginia-Carolina Chemical Co., is now chemical engineer with the Provident Chemical Works, St. Louis, Mo.

* * *

R. T. Hewitt, general superintendent of the Bayway, N. J., plant of the Standard Oil Co. (N. J.), has retired on a pension after a continuous service of forty-one years. His successor is J. R. Carringer, who for the past three years has served as assistant to Mr. Hewitt.

* * *

G. St. J. Perrott, associate physical chemist of the United States Bureau of Mines Experiment Station, Pittsburgh, Pa., has been transferred to Tuscaloosa Experiment Station, Birmingham, Ala., to study the physical properties of coke in relation to its production and use in the blast furnace.

* * *

William S. Congdon, assistant head of the dye department of the American Thread Mills, Willimantic, Conn., has been appointed a Federal prohibition agent. Mr. Congdon will take up his new duties September 6 as the head of a group of agents operating in the eastern part of Connecticut.

* * *

Changes in the du Pont sales staff embrace the appointment of Cesare Protto as assistant director sales division of the dyestuffs department vice E. C. Patterson, resigned, and of Robert S. Hunt, class '97, Massachusetts Tech. chemical engineer, as manager of the Boston office, with Charles H. Scott as assistant.

* * *

Pedro Morel of the Millinckrodt Chemical Works, St. Louis, Mo., has returned from Buenos Aires, Argentina, where the company has an office and expresses himself as far from optimistic as to the present opportunities for extensive trade in chemicals with South America. Large shipments of chemical products are in storage in the customs house in Buenos Aires because the purchasers have failed to accept them. Credit conditions are difficult. Mr. Morel finds, and the best customers will not consider orders except on a long term credit basis. Payments are also very slow.

Industrial Notes

The Paterson Chemical Co., Paterson, N. J., is the enterprise of George Tierney and E. J. Eimer, formerly of the Parlin, N. J., plant of the Hercules Powder Co., in the production of pyroxylin lacquers.

* * *

The Solvay Process Co. will reopen its plant at Delray, near Detroit, Mich., with about 1,500 men, September 1, after a shutdown of two months. Operations will be 50 per cent. of capacity.

* * *

A 10 per cent. reduction in salaries, effective October 1, has been announced by E. I. du Pont de Nemours & Co., following a meeting of the board of directors on August 29th. The cut will affect all salaries from that of the president down.

* * *

Acetate Products, Ltd., capital \$250,000, is building on the Fraser River near New Westminster, B. C., a plant for the production of methanol, charcoal and acetate of lime, the first of its kind on the Pacific Coast. P. A. Carlston, New Westminster, B. C., is plant superintendent.

* * *

The Tidewater Glass Co., capital \$1,150,000, Jacksonville, Fla., has been organized by Harry A. Neff, president, Belmont Tumbler Co., Belvedere, Ohio, to utilize the white sea sand near Jacksonville, which is also adapted for the manufacture of all kinds of glassware. The plant will be the first of its kind in Florida.

* * *

The Ohio-Kentucky Fluorspar and Lead Co., Paducah, Ky., recently organized with a capital of \$1,000,000, is planning for the construction of new works in the vicinity of Smithfield, Ky., with daily output of 100 tons. It will include crushing plant, refinery, etc., and is estimated to cost in excess of \$200,000. The company has acquired the property of the North American Fluorspar and Lead Corporation in this section. T. J. Clay is president, and F. B. Moodie, vice-president and manager.

* * *

Interstate Commerce Commission regulations for the shipment of dangerous articles have been amended to read as follows:

Arsenic, paris green, arsenate of lead, calcium arsenate and all other strongly poisonous articles must not be offered nor accepted for shipment in bulk, but must be packed in strong and tight containers which will prevent sifting or escape of contents in transit, provided that sintered arsenical flue dust may also be shipped between plants in steel gondola cars equipped with suitable covers.

* * *

The Eastman Kodak Co., Rochester, N. Y., will transfer its chemical manufacturing departments to a new industrial development, called Kodak Park West, in contradistinction to its present site where space is not available to accommodate the growth of chemical manufacture. Kodak Park West embraces an area of 58 acres. A power plant is now in course of erection to supply the departments that will be transferred, viz., cotton storage, nitro-cellulose manufacture, flash powder, photographic chemicals, etc., on the erection of the necessary structures.

* * *

The Viscose Company of America has purchased from the Charleston Industrial Corporation a site known as Area E of the former Government powder

town of Nitro, W. Va., comprising fifty-two acres. The War Department joined in giving the company a clear title to the property, which lies in the centre of the manufacturing area. Three large pulp mills are included in the purchase. Dr. C. F. Ernst, president of the company, announces that pulp will be manufactured at the Nitro mills from cotton linters for use in artificial silk manufacture at its present plants at Marcus Hook, Pa., and Roanoke, Va.

* * *

The Valley Paper Mills, Inc., Neenah, Wis., recently organized with \$800,000 capital stock, has acquired a water power site of 17 acres at Blair Springs on the Fox River, and is having plans prepared for a paper and pulp mill and auxiliary buildings, to cost with equipment about \$600,000. The architect is Edward A. Wettengel, Appleton, Wis., and the engineer for equipment, etc., is Albert C. Ehlman, 835 Caswell Block, Milwaukee. The main building will be 80 x 550 feet, part two stories; the boiler house and engine room, 60 x 165 feet; machine room, 80 x 170 feet; beater room, 80 x 100 feet, and finishing room, 80 x 150 feet, all of brick and steel on concrete substructures. G. W. Burnside, Neenah, is general manager.

* * *

The American Woolen Co., the largest factor in American woolen manufacture, reports all its plants as operating at capacity with the largest force employed in its history. In the cotton textile industry cloth mills are estimated to be operating from 80-85 per cent. capacity and yarn mills at around 65 per cent. capacity. Mill production is steadily growing and is larger now than at any time this year. The International Paper after a recent strike experience reports a daily production of 400 tons, mostly newsprint, with eight mills operating as against a normal daily production of 1,200 tons, two-thirds of which is newsprint. Of the company's labor troubles, President Philip T. Dodge says:

"I wish to say emphatically that we are through with unionism. Of course we do not object to organization within the circle of our own employes, but we insist on an open shop basis. It is true that the men have more money at the end of the year on the open shop plan than they have under the closed shop with strikes and delays. We are handling our wage settlement independent of the Board of Arbitration which recently announced reductions for both skilled and common labor. Hereafter all our mills will be non-union."

The Central Leather Co. announces business in sole leather at 60 per cent. of normal and its production less than 60 per cent. of capacity. The Anaconda Copper Company's production has been shut down entirely since April, with only 2,600 men at work to care for idle plants and properties.

POSITION WANTED

DEVELOPMENT and invention in the fields of petroleum and asphalt refining, thermoplastics, resin and pitch products, gasoline production; as well as supervision of manufacturing processes. Graduate chemist (M. I. T.) desires connection with progressive company interested in the above and allied fields. Capable of acting as patent solicitor and manager or assistant manager of development work. Salary dependent on responsibility. Address: M. M., care of CHEMICAL AGE.

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Present and Future Sources of Energy

Dwindling Energy Resources Compel Attention to the Utilization of Primordial Forms

By Dr. Arthur D. Little

THE world cries for work to be done. Debts must be paid. Stupendous material losses must be made good. Crushing burdens of taxation must be lifted. Ways must be found to satisfy the reasonable demands of workers inspired by a new social consciousness. There are houses to be built—many, many houses. There is new equipment to be fabricated, broken-down systems of transportation to be reconstituted, factories to be restored. There are villages and towns to be rebuilt and roads to be made; there are millions of people in need of food; there are whole nations to be rehabilitated.

To do this work the world requires a supply of available energy incomparably greater than the race has ever before been called upon to utilize. And, moreover, this supply must be developed and applied and this work initiated and carried forward at a time when human energy is nearly everywhere impaired and even at its lowest ebb in many great communities. We face a situation of unprecedented gravity, which is further complicated by social forces and economic pressures that may even disrupt our civilization, unless we can provide the means by which these forces shall be directed and these pressures relieved.

Only Work Can Soothe a Feverish World

Political expedients designed to relieve symptoms may for a time be palliative; they cannot effect a cure. The trouble is constitutional, and the remedy must strike its root. There is one such remedy: no other is likely to appear and that remedy is work. This remedial work is not, however, the work of the man with the hoe: it is the work of the farm tractor; not that

of the Chinese transport coolie, but of the locomotive engineer with a hundred loaded freight cars behind him; not the back-breaking effort of blowing a forge

by hand, but the manual control of turbo-compressors forcing the fires of the blast furnace. It is, in short, work on the grand scale, in which the material sources of energy are drawn upon to the utmost extent to which we are capable of using them, while human energy supplies the controlling, regulating, and steering agency.

Many minds have realized and phrased the thought expressed by Sir Oliver Lodge in the words: "All that the human race can do in the material world is to move matter. Locomotion in one form or another is the business of man." If, therefore, we are to work on the grand scale, do business on the grand scale, which the social and economic exigencies of the times require, we must learn how to develop and utilize energy on the grand scale. That energy must, moreover, be in forms best suited to our immediate requirements, and it must be used to far better advantage than ever heretofore.

Just as the nineteenth century was signaled by the definite enunciation and development of the theory of energy, so was it also rendered memorable by the larger

units of energy made available to the individual worker. In 1770, except for a few small water powers, some wind mills and sailing vessels, and here and there in England a Newcomen engine for pumping water from the mines, the total power available to the world was that of human beings and draft animals. There were no railroads, no canals. The roads were bad, and the traveler was at the mercy of the highwayman. It cost



DR. ARTHUR D. LITTLE

as much to transport a ton of goods ten miles as it costs today to send it fifty times as far. Industry was cramped and necessarily localized; its markets were restricted; and its rewards were meagre.*

Wealth must be produced before it can be distributed. By 1870 or within one hundred years 18,000,000 horsepower had been developed in Europe and America by the steam engine, and by 1900 the total horse-power so developed was over 70,000,000. The steam engine was only one of the factors responsible for the Industrial Revolution, but it was a fundamental one. It provided the essential energy, without which the Revolution would have been aborted, and it supplied that energy in the larger and larger units demanded by the new industrialism. Meanwhile, through the collateral development of many ingenious mechanisms each unit of energy under the rudder control of the human operator became increasingly effective in the work of production and transportation. Through the agency of electricity it became possible to combine the economies of large-scale power generation with the advantages of wide distribution and the minutest subdivision.

The progress of science and invention stimulated manufacture, opened new markets, supplied new raw materials, created new wants, and furnished the means for their measurable satisfaction. Whether all this has, thus far, correspondingly increased the sum total of human happiness is questioned by many thoughtful minds.

We may, however, confidently claim that it has notably raised the general standard of living, lowered the poverty line, brought down the death rate, maintained greatly augmented populations, and caused the world to shrink. Whether we will it or not, we are being brought closer and closer together. Density of population and innumerable contacts with their fellows have made the Chinese the politest people in the world. May we not assume with some approach to certainty that through the more intimate contacts that our increasing control of energy is forcing upon us will come better understanding, more consideration, closer cooperation?

May we not go further and affirm, without fear of contradiction, that the failure of modern industrialism to bring a larger measure of satisfaction to the soul in great classes in the community is properly attributable to the limitations and imperfections of human nature as it manifests itself in every class?

In a recent striking address before the American Bar Association by James M. Beck, Solicitor-General of the United States, occurs this paragraph: "The morale of our industrial civilization has been shattered. Work, for work's sake, as the most glorious privilege for human faculties, has gone. The aversion to work is the great evil of the world today. The less a man does the less he wants to do. The whole history of the mechanical era is a persistent struggle for shorter hours, and today it has culminated in world-wide ruin."

It is obvious that if we are to continue, as we must, to augment greatly the already vast increase in "the potential of human power," we must find the way to bring about a corresponding increase in "the potential of human character."

Among the many factors involved in the situation to which Mr. Beck refers one of the most conspicuous and far-reaching in its influence is the prevalence of false values. They imperil the amity of nations, embitter class relationships, upset the economy of households, and bring to the individual envy and discontent.

We may, therefore, note with tempered and restrained optimism the few circumferential signs that seem to indicate a nicer discrimination in appraisal. Silk shirts are now less generally regarded as essential to happiness, and even the vogue of the movies is waning. We may yet reach the point where a good book is preferred to a poor picture, even though the picture moves through the Ten Commandments and breaks them all.

Labor Productive Only as Energy is Available

In all communities are those who claim, with a certain superficiality of justice, that all wealth is produced by labor. But the amount of wealth that labor can produce is determined by the amount of energy placed at the disposal of the laborer and by the efficiency with which, under the guidance of management, he is enabled to utilize that energy.

The amount of food consumed daily by the average New Yorker has about the same energy content as one-half pound of coal, and, like the rest of us, he is commonly unwilling to convert all that energy into useful work. Properly applied, however, the proportion so utilized in brain power may suffice to run a railroad or dominate an industry. In less favored sections of the country a few men by utilizing gravity may launch a warship. By the use of compressed air the output of the human riveter is increased from fifteen to twenty times. Hydraulic devices enable one man to operate the locks of the Panama Canal. By a delicate utilization of energy we talk from Paris to Honolulu or fill the ether with wireless music available to all who will buy a \$40 receiver.

Upon what sources of energy may the world draw for the stupendous work of reconstruction and the requirements of the new social era, at the threshold of which we seem to stand?

In appraising the sources of energy we must consider form values as well as quantities available. Gasoline can be utilized more effectively than coal. The development of water-power involves a heavy initial expenditure, and therefore interest charges are the chief item of expense. In a steam station of the same considerable size—20,000 h. p.—interest shrinks to less than 20 per cent. of the operating charge, and the cost of coal at \$3.25, delivered, is nearly 50 per cent.

Solar Energy

We are cognizant of sources of energy inconceivably greater than any possible requirement of the human race. There is to be considered, first of all, the radiant energy of the sun, of which Lodge assures us the earth receives only one-hundred-and-fifty-millionth part. It seems too little to talk about. It is only three small calories per minute per square centimeter of the earth's surface. But Ciamician has calculated that a surface of only 10,000 square kilometers (3,861 sq. mi.) receives in a year, assuming only six hours as the effective day, a quantity of heat that corresponds to that produced by the burning of 3,650 million tons of coal. That is considerably more than double the entire world production.

The desert of Sahara, with its 6,000,000 square kilometers (2,316,600 sq. mi.) of area, receives daily solar energy equivalent to that of six billion tons of coal. The world awaits the genius who will convert radiant energy into electric current. Of that minute portion of the solar energy received by the earth only about 1/300 part is stored up by the plants. They, nevertheless, produce annually, according to Ciamician, 32 billion tons of vegetable matter, which, if burned,

*Presented September 8th at New York Meeting of the American Chemical Society.

would develop a quantity of heat equal to that derived from the combustion of 18 billion tons of coal.

The energy of the earth's rotation is a matter for the astronomers. It is undoubtedly of the order of magnitude to which they are accustomed, but by which chemists and others are confounded. It has been thus far utilized only by Mr. Sperry in his applications of the gyroscope. Somewhat similarly, we may recall, the Greeks rubbed a piece of amber and picked up a feather. The other developments of electricity came a thousand years later.

The energy of the wind and the closely allied energy of the waves are too uncertain and diffuse to justify extensive exploitation.

Tidal Energy

In a few exceptionally favorable locations it is feasible to utilize a trivial fraction of the total energy of the tides. The intermittent flow, the varying head and other special conditions involved in the problem are likely to hold the development of tidal power within closely restricted limits. It is, nevertheless, reported that two significant developments are now under consideration: One, by the French Government, at St. Malo, where the picturesque River Rance finds outlet in the quaint old harbor, where the tide rises 30 ft.; the other at the mouth of the Severn River, by the British Ministry of Transport. Here, again, the tidal range is 30 feet.

The proposal involves throwing a dam three and a half miles long across the Severn estuary and the installation of hydroelectric turbines with an integrated capacity of 1,000,000 horsepower, but an available output on the continuous basis of only about 437,000 horsepower. The excess capacity will be utilized in pumping water to a high-level reservoir for delivery during the hours of enforced idleness of the turbine plant in the main dam.

The studies by Norman Davey of the available tidal power of the British Isles led him to fix the total at a little over $2\frac{1}{4}$ million horsepower in terms of average continuous power. Since, however, it is, in fact, available only as intermittent power, much larger installations are required to maintain the average rate. Since the capital charges against hydroelectric power are normally high, this requirement would seem to render them excessive in case of tidal power.

Internal Heat of the Earth

To those who have seen the pictures of the Valley of a Thousand Smokes in Alaska, or who have witnessed a volcano in eruption, there is no need to attempt to give quantitative expression to the forces responsible for the imposing spectacle. It seems improbable that the vast store of energy existent as the earth's internal heat will ever be available to us in any substantial measure. A recent news item, however, referred to a 30,000-hp. steam-turbine installation in Italy, which derives its energy from steam issuing from vents in the side of a volcano.

Atomic Energy

Of extraordinary interest to chemists are the accumulating evidences of inconceivably great amounts of kinetic energy possessed not only by radium but by ordinary matter as the constitutional energy of its atoms. Fortunately for science some atoms—those of the radioactive elements—are surcharged with energy. They lose some of it spontaneously, thereby setting up the

remarkable phenomena which drew attention to the facts with which you are all familiar and caused us to revise our fundamental conceptions of the constitution of matter and the interrelations of the elements.

We now recognize that concealed in matter of every kind are stores of energy immensely greater than those derived from chemical reactions or concerned with any of the forces with which we commonly deal. We recognize them as of an altogether higher order of intensity and magnitude than the energy derived from burning coal or liberated from the most powerful explosive.

So stupendous and far-reaching are the possibilities contained in the suggestion that we may ultimately be able, without destruction, to draw upon this energy supply that Rutherford has said, "The human race may date its development from the discovery of a method of utilizing atomic energy." At this stage of our social development, with its possibilities of international friction and misunderstanding, it is perhaps fortunate for civilization and ourselves that this discovery has not yet been made. We have still far to go before we adequately utilize the energy reserves already at our command.

Coal Resources

Our civilization is based on coal. It will be based on coal for many generations to come, in spite of tendencies which seem to imply that the burden is shifting to petroleum. However far the transfer may proceed, the carrying power of petroleum is temporary and likely to be brief. What, then, are the coal resources of the world, and how are they distributed?

Reported in units of one million tons, the estimate of the Twelfth International Geographical Congress, which convened in 1913, may be summarized in round but closely approximate figures as follows: Including 3,000,000 units of lignite, the world's total coal reserves are about 7,400,000 units, of which over 5,000,000 are in North America, 1,280,000 in Asia, 784,000 in Europe. The known supply of Africa is slightly more than 1 per cent. of that of North America, but Africa has nearly twice as much as South America. Australia is credited with 170,000 units, or about three times the African reserve.

These estimates of the world's reserves undoubtedly include much very inferior coal and much that cannot be mined without great difficulty by reason of its depth or the manner of its occurrence. There is, therefore, a considerable divergence among authorities in their classification into actual, probable and possible reserve in the various regions of the world.

The broad facts are, however, well established and are sufficient for our present purpose. The actual reserve, or coal of which there is definite knowledge, is little more than half the total estimated, and of this actual reserve about four-fifths is in the United States. The production and use of coal in the various countries does not, however, stand in any direct relationship to their reserves. The world's production in 1913 was 1,478,000,000 short tons, of which the United States contributed about 570 million, Great Britain 321, and Germany 305 million. Japan, with total reserves below 8,000 million tons and a relatively small production, is a large exporter of coal.

In Great Britain the high quality of the coal and the short average haul of only 20 miles to the coast have not only greatly encouraged the extension of British shipping but have established the world's greatest export trade in coal. Considered economically and in

view of England's seriously depleted coal reserves, this trade begins to assume the character of a transfusion of blood, admirable for the receiver, but weakening to the contributor.

Natural Gas

Natural gas has been aptly designated "Nature's bonus to America." One-tenth of our population are wholly dependent upon it for lighting, cooking and heating, but even so, its larger uses are industrial. About two-thirds of the total output is burned in manufacturing plants under boilers or utilized in metallurgical operations, cement kilns, glass-making and pottery furnaces. Much of the cheaper gas is burned for carbon black.

Natural gas is a waning resource. It has been wasted shamefully. In volume, waste has run parallel with use and often outstripped it. In 1917 we used about 800 billion cubic feet, which was three-fourths of all gas sold in the country. We also wasted 800 billion cubic feet and with it much gasoline. We are not wasting quite as effectively now. The supply is running out, and our 1920 production was below 650 billion.

Petroleum

The same phrase applies with equal force to our development of petroleum, of which the United States now produces about 70 per cent. of the world's supply. As in the case of natural gas, our reserves are rapidly nearing depletion and can hardly maintain our present rate of production for more than twenty years. We have wasted more than we have used. Our 260,000 producing wells leave more than half the oil underground, and less than half of what they take out reaches the pipe line. Then we burn half of that as a substitute for coal, of which we have 6,000 years' supply. We need an intelligent economic policy in these United States and power to enforce it. The basic cause of this orgy of waste and the unrestrained production that makes it cheaper to burn oil than coal is the small individual holding. The owner *must* hustle to get his oil out or it will be taken by others from under his feet.

Nearly 5,000,000,000 barrels of petroleum have been produced in the United States since the Drake well was drilled in 1859. We are now thought to have about 7,000,000,000 barrels remaining, from which we are now drawing nearly 400,000,000 barrels a year on a rapidly rising curve of production. Most of the oil elsewhere is now under British control, and nothing is more certain than that we shall lose our supremacy in the field of oil production, though we are consuming 80 per cent. of the world's output and becoming daily increasingly dependent upon oil in industry and transportation. Guesses at the remaining world supply of this peculiarly essential energy resource range from 43 to 60 billion barrels.

There are about 8,500,000 motor vehicles in this country, representing at a conservative estimate a generating capacity in gasoline engines of 212,000,000 hp. One manufacturer is adding to this an integrated capacity of 94,000 hp. a day. Requa estimates our gasoline demand in 1930 at 300,000,000 barrels. Meanwhile it looks as though the old firm of Demand and Supply might be dissolved.

Energy Conservation by Plants

Ciamician has estimated that the solar energy stored

by plants produces 32 billion tons of vegetable matter annually, equivalent in heating power to 18 billion tons of coal. The cost of collection deprives these figures of much of their significance, but they point, none the less, to striking possibilities in the production of power alcohol. Meanwhile our peat supply is building up. But peat, though already available in vast amount, must be classed with oil shale as an energy reserve, valuable when needed.

Water Power

The rising price of coal has tended to focus attention upon water-power, although this tendency has been marked and of more stimulative effect abroad than here. The water-power resources of the United States are sufficient to operate every factory and light every build-in the country, but their general development is inhibited by the cost of money for enterprises in which bond interest constitutes 77 per cent. of operating costs.

In recent years only about 10 per cent. of our power expansion has been deflected to water-power, though from 100 to 200 million horsepower, well distributed geographically, awaits development, of which 50 million is capable of use without the creation of unduly expansive storage. General development is likely to be deferred until the best of our coal and oil is gone. Meanwhile, very important hydroelectric developments are proposed or under way in Europe.

More Efficient Utilization

Since coal must remain for generations our chief energy resource, the line of progress parallels the better utilization of coal. Here a vast deal may be accomplished. Coal should be better cleaned. It should be fired under close scientific control. Heat losses should be minimized; power generation should be centralized, and small plants encouraged to buy their power.

Inferior fuels should be utilized as powdered coal. The beehive oven should go. Coal mining should be integrated. We may expect notable developments in the processing of coal and the more effective utilization of coal products.

As the cost of human energy goes up, that of the energy derived from nature must come down, if social progress is to be maintained. Energy is the economic support of progress. If that support is to be adequately afforded we must have cheap energy. We can have cheap energy by better administration, better development, better application. With cheap energy we need common-carrier transmission lines, like those contemplated by the Superpower Survey, to make that energy available over wide districts.

Gilbert and Pogue have summarized the situation admirably as follows:

Resource energy as the source of power, heat, light and chemical work is the basis of industrial activity and social advancement. The quantity of energy required in the United States has grown to such stupendous proportions that its provision in the customary manner is becoming increasingly difficult, with growing uncertainties of supply and rising costs.

A complicated civilization is dependent upon a system of energy supply which has failed to adjust itself to changing circumstances with sufficient rapidity, and in consequence industrial and social progress is building upon a failing and obsolescent foundation. The need is for adjustment in energy form to the end that greater efficiency in utilization and transportation shall be obtained and a full measure of resource value received.

Handling Liquid Chlorine

By D. K. Bartlett

Vice-President, Electro Bleaching Gas Co.

CHLORINE in liquid form has now been used in this country since 1907. In common with all other compressed gases there are very definite and careful regulations drawn by the Interstate Commerce Commission governing its transportation. Under these regulations there are four accepted containers in which the material may be moved, namely, those which carry 100 lbs., 150 lbs., 2,000 lbs., and 30,000 lbs. As there have been no accidents in interstate commerce since the regulations have been in force it would seem proper to assume that the regulations are right, as they now stand.*

The use of chlorine has become very widespread through the textile industry, the public water supply system, the flour industry, the chemical industry and the pulp and paper industry. Liquid chlorine today is stored at from 4,000-5,000 different points in quantities varying from a few cylinders to many thousand pounds. So far such regulations covering storage as have been in force are simply those recommended by the producer to the consumer. Safety is of prime importance to the producer as well as the consumer, and while the hazard is much less than is commonly supposed, it is, nevertheless, sufficient to cause the producers to adhere to and recommend regulations which make the use of this material safe.

Hazards of Compressed Gases

It may be well at this point to consider briefly the hazards of compressed gases in general.

As long as the gas remains in the container, it is obvious that it can do no harm irrespective of its effect when released. It is therefore necessary to consider the probability of escape of gas from the container, as well as the qualities of the gas itself. Escape of gas from a container may be due (1) to a true explosion, (2) to an increase of pressure, due to heat, sufficient to rupture the container, or (3) to leaks.

If the gas escapes from the container, the resulting hazard may be due (1) to inflammability, (2) poisonous effects, or (3) to irritating effects, with interference with sight or respiration.

Hazards of Liquid Chlorine

Considering now the specific case of chlorine, we can eliminate hazards due to explosions, for it is non-explosive. The chance of a rupture arising from hazards due to increase of pressure is very slight because of the high critical temperature of chlorine. The following table gives this temperature for a number of common gases:

Chlorine	146	Carbon Dioxide	31
Ammonia	132	Oxygen	-118
Acetylene	36.5	Hydrogen	-240
Nitrous Oxide	36.5		

By Interstate Commerce Commission regulations all cylinders and ton drums are provided with fusible plugs which melt at 158° Fahrenheit, at which temperature the pressure is about half the test pressure of ton drums at time of manufacture and a quarter of the test pressure of the smaller cylinders.

There has never been an instance of bursting of a container in transit or in a user's plant.

There have been four or five cases of the rupture of

containers in the manufacturer's plant due to the presence of foreign material in the container which reacted with the chlorine. To guard against a repetition of such accidents, all manufacturers now have in force a rigid system of inspection of empty containers. Even should a container with such foreign material be filled, any trouble resulting necessarily will develop within a few hours, so that any hazard existing from this cause concerns only the manufacturer, not the user or the carrier.

There also have been a few cases of fire where a large quantity of chlorine has been stored. In each case the upward draft due to the heat of conflagration has been strong enough to carry the gas upward and cause a sufficient dilution so that the fire fighters were caused no inconvenience in their work.

As regards leaks: Here the evil smell of chlorine is its own greatest safety factor. Its presence in the atmosphere can be detected in very minute quantities through the sense of smell. After the person in charge of the use of the chlorine in any plant has had his first considerable whiff, he is quite ready henceforth to take necessary precautions and to follow the instructions laid down by the manufacturer.

The next safety factor is the slow absorption of the heat necessary to evaporate the liquid into a gas. The following table gives the rise of temperature of the liquid chlorine in a tank car during a period of 96 hours:

Time	Temp. of Contents	Change during period	Pressure sure	Change during period
Start	-9° C.		64 lbs.	—
End 24 hours.....	-2° C.	7° C.	76 lbs.	12 lbs.
End 48 hours.....	+3.5° C.	5.5° C.	88 lbs.	12 lbs.
End 74 hours.....	+5° C.	2.5° C.	93 lbs.	5 lbs.
End 96 hours.....	+8.5° C.	2.5° C.	98 lbs.	5 lbs.

Precautions

When the odor of chlorine is noticed the source should immediately be located. Never hunt a leak through the sense of smell. Always have a gas mask handy and be sure you have fresh canisters. The mask is not apt to be used, but it gives confidence to the one hunting the leak.

Have a bottle of aqua ammonia and a piece of waste fastened to the end of a short stick. Dip the waste into the ammonia and start your search. The moment you come to chlorine in the air, a white fume of ammonium chloride will appear. As you reach a denser volume of chlorine the white fumes are denser. Thus the leak is quickly located.

If this leak is in the piping, etc., shut off the valves at the containers and repair. If in a valve on the container or in the container itself, and it cannot be stopped, connect the gas valve from the container to the absorption system and begin to operate. The liquid cannot evaporate in the containers, without the application of heat, as fast as the gas is absorbed in the system, and thus the leak quickly stops.

Properties of Chlorine

Chlorine is unflammable. It is not poisonous in the sense that carbon monoxide or phosgene, for instance, is poisonous. We therefore can eliminate hazards arising from flammability and poison and confine ourselves to the hazards of irritation.

The immediate result of inhaling a large quantity

*Read at the National Safety Congress, Boston, Mass., September 28, 1921

of chlorine gas is inflammation of the tissues lining the throat, with resulting coughing and nausea. While it is highly irritating and extremely uncomfortable, inhalation of chlorine is never fatal unless the subject remains for a considerable period in an atmosphere of highly concentrated gas.

Should a person be affected by chlorine gas the following treatment is recommended: Remove at once to the open air and away from all gas fumes. Place the patient flat on his back with head slightly elevated, and give a half teaspoonful of essence of peppermint, or a moderate dose of bromo-seltzer or whiskey (?). This will relieve the tendency to cough and soothe the inflamed membranes, allowing the passage of air and promoting the action of the respiratory organs. The person affected should himself resist as much as possible the impulse to cough. A mustard plaster on the chest will give prompt relief. While there are never any serious after effects, a physician should always be called.

Storage of Chlorine in Cylinders or Drums

The storage space should be selected with an eye to easy unloading and transfer to the absorption room. Either of the smaller cylinders may be readily unloaded from a car and rolled over a floor by one man, but if possible, overhead trolley should be installed for carrying them. They are suspended from the trolley by a chain block and grasped by a pair of tongs made especially for this purpose. Cylinders are usually handled and stored in an upright position.

Ton drums are shipped in gondola cars, each drum resting in a cradle. In unloading them it is therefore necessary to lift the drum clear of the car by means of a chain block and crane or similar device, after which it may be conveyed to the absorption room by either rolling over a level floor or track or carried by an overhead trolley or industrial car. Ton drums are always used and stored in a horizontal position. The storage had best be under a roof, but without sides on a concrete floor above any possible flood line. It would hardly seem necessary to enclose the storage space to protect against unauthorized handling of the cylinders.

The Tank Car

The large user may receive this material in the 30,000-lb. container, which is permanently fastened to a standard freight car, and thus becomes a tank car, and so freight is paid only on the contents. This means a very large saving in the delivered cost of the bleaching material. Thus far the major portion of the material moved in tank cars has been delivered from the car directly into the absorption system, the cars in many cases being emptied in from 4-6 days. Here again is a marked reduction in cost due to elimination of handling charges.

Mills using liquid chlorine, who can take tank-car deliveries, should face the storage problem. There are two methods open, viz., (1) the filling of the 2,000-lb. container or the so-called ton drum, or (2) fixed tanks large enough to take one tank car only. Both methods are now being installed for the purpose of getting comparative data.

Inasmuch as local condition affect the storage problem a detailed discussion of the best method of storage is useless—at least at the present state of the art. The problem, however, is one which readily can be worked out for any particular case.

Scientific Instrument Co., Max Links, pres., to provide larger manufacturing space, has transferred its headquarters from 239 E. 41st st. to 46 Vesey st., New York.

Commercial Wood Preservatives from Coal Tar

Editor, CHEMICAL AGE:

In your issue, Volume 29, No. 8, Page 319 to 323, is an article about sugar refining by George M. Rolph, general manager of the California and Hawaiian Sugar Refining Corp. Apparently one-eighth of this article is devoted to the destruction of piling by marine borers. It would seem that the author's interest in marine borers at the time of writing this article must have overshadowed in his mind the main parts of his subject. At any rate, he has gone considerably out of his way to take a rap at the quality of creosote oil with which some of the piling driven in the San Francisco Bay region in recent years has been treated.

Mr. Rolph states: "Close study shows that the manufacturers removed the 'dye basis' portion of the oil, i. e., naphthalene, anthracene, pyridine, acridine, quinolin and aniline, all of which constitute the heavier oils, leaving the lighter oils which more readily leach out. In reality, the creosote oil on the market is a by-product and not a whole oil. The Committee on Preservation of the American Wood Preservers' Association is now revising specifications so as to insure the user he is getting the best grade possible, not, however, without vociferous objections on the part of some of the producers."

One is compelled to wonder whether the foregoing statement does not constitute the tail which is wagging the whole dog of Mr. Rolph's article. This, however, is of no consequence to the writer excepting to point out that the "close student" who discovered what the manufacturers were doing, is absolutely incorrect in his conclusions. Of the seven compounds ending in *ene* or *one* which the student claims are being removed by the manufacturers, only one, viz., naphthalene, which from a creosote standpoint is a low-boiling or light constituent, is actually being removed from creosote oil to a degree of tonnage at all measurable in comparison with creosote oil production. One of the compounds mentioned, viz., aniline, has never been produced commercially from creosote oil and could not be produced at all except possibly in minute amounts at a cost so far above its selling price that it would be of interest only from a scientific standpoint.

Even the layman, to say nothing of the "close student," should know in these days of chemical publicity that aniline is produced from benzol which is obtained from coke-oven gas and not from creosote oil. The statement that "these compounds constitute the heavier oils, leaving the lighter oils which more readily leach out" is also untrue. Of the compounds mentioned, some are relatively light and some heavy. It already has been pointed out that naphthalene is a relatively low-boiling or light constituent, as is pyridine; while anthracene and acridine are relatively high-boiling and heavy. The compounds mentioned are neither more nor less readily leached out than the other constituents of the oil.

The Committee on Preservatives of the American Wood Preservers' Association already has pointed out at some length to the San Francisco Bay Marine Piling Committee the fallacy of very similar statements which that Committee had received, and these statements, according to the records of that Committee, did not originate with Mr. Rolph, but with a certain manufacturer of creosote oil who may have had interests in the matter which were not altogether altruistic.

S. R. CHURCH.

40 Rector St., New York.

The Future of British Chemical Industry

By Sir William J. Pope, D.Sc., F.R.S., K.B.E.

Retiring President, Society of Chemical Industry

S EVEN years ago the situation and the outlook in all branches of scientific industry were very different from those which now confront us. In 1914 certain of the chemical industries of Great Britain were expanding slowly but steadily, while others were slowly but just as surely shrinking before foreign competition; in some of the chemical industries Great Britain was supreme, but in others we were losing ground. At that date chemical industry was expanding rapidly in this great Dominion of Canada, and all the virility of a growing population was being devoted to the utilization of the vast natural resources of a previously but partly developed country.*

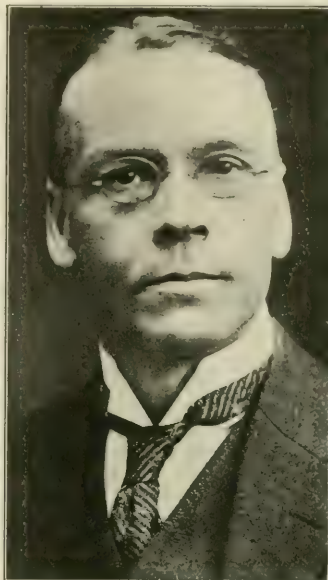
The interval has seen the commencement and the conclusion of a great conflict, a war which has reduced to mediocrity several of the dominant European powers, and has left nearly every nation struggling under an accumulation of debt. Throughout the war Canada, like every component of the British Empire, devoted itself actively to the production of food-stuffs and of munitions of war; although the great majority of valiant manhood of all countries entered active service we were successful in establishing on a grand scale the manufacture of the many and varied chemical products required for military purposes.

One of the vast problems which the war has bequeathed to us is that of determining how the faculty which we exhibited in the manufacture of chemical products during a period of emergency is to be diverted and utilized for peace purposes.

Post-War Problems

The problem is an entirely novel one in that it is accompanied by certain factors which were previously absent or which were at any rate of subsidiary importance. Thus, it cannot be doubted that the bonds uniting all parts of the British Empire have become far stronger in consequence of the events of recent years; further, we realize to a greater extent than ever before that for purposes of production our Empire must be, if not absolutely self-contained, at least in possession of trades which could be rapidly mobilized so as to render us self-contained.

Before the war we were dependent on Germany for bromine and for coal-tar colors and upon the Dutch colonies for quinine; the price of these and other essential products quickly rose to famine prices, although no reason exists why they should not be produced within the Empire just as conveniently and just as cheaply as abroad. So completely has the necessity for a British production of great numbers of chemical products been



SIR WILLIAM J. POPE, D.Sc., F.R.S., K.B.E.
Retiring President, Society of Chemical Industry

brought home, even to the man in the street, that action has been taken in order to remove the former disabilities.

The extent to which success has attended these efforts is open to comment, but it is at least certain that if we ever again find ourselves in a position of embarrassment owing to the absence of British sources of supply of essential chemical products, our political leaders will have to exhibit considerable agility in shifting the blame on to other shoulders than their own. All the bromine we require could be obtained as a result of the introduction of rational chemical methods into the production of salt from sea-water in India; all the quinine required could be furnished cheaply by the scientific cultivation of cinchona in our Colonies; and the British production of complex organic explosive materials during the war has entirely swept away the ancient propagandist doctrine that the manufacture of fine organic chemicals, including coal-tar dyestuffs, is incompatible with the British temperament.

British and German Environment in Chemistry Contrasted

All these are matters of great importance; but one further consideration has become accentuated during recent years, and accentuated by the fact that the major portions of the tropical regions of the world are administered by the English-speaking and the Latin nations. In the past we have, I venture to think, endeavored to build up our chemical industries far too much on the lines which proved so fruitful in Germany. I am speaking now not of the heavy chemical industry, in which we have always been to the fore, but of those industries which involve the production or the use of a great variety of complex organic compounds.

The organic chemist has long had before him, as one great object to his work, the artificial production of the myriads of organic compounds which we find among animal and vegetable products. He may be justly proud of his achievements in this direction, and the success attained justifies our belief that we shall within quite a short time be able to prepare in the laboratory any compound substance formed by the animal or plant.

Immediately some important natural product of commercial value is produced in the laboratory, the German technologist has sought to convert the laboratory method into a works process capable of competing with that of the plant or animal. From the standpoint of the German economist this course of action was sound. Germany had but few colonies, and those few, since the German Government did not possess the art of colonial administration, were a source of considerable expense to the fatherland. We have relieved Ger-

*Presidential Address at the Annual Meeting at Montreal of the Society of Chemical Industry.

many of this expense and thereby have stimulated the German instinct for making in a chemical works those chemical products given to us by tropical nature.

My point in suggesting that we have erred in adopting German views concerning the methods and aims of chemical technology, without reflecting that economic conditions in Central Europe are entirely different from those which prevail in the British Empire regarded as a whole, perhaps calls for some explanation. The necessary elucidation may be furnished by considering the ultimate object of technical chemical effort.

The object of all technology consists in converting raw materials of inorganic or organic origin into products of greater value by expending upon them a certain amount of labor and a certain amount of energy. To a Central European nation labor means high wages to its population and energy means mainly coal or water-power; only one type of technological process is thus in the main to be considered, and this is one in which certain raw materials enter the works to be handled by costly labor and to be treated by the burning of fuel, which is another form of costly labor.

German Synthetic Rubber vs. British Rubber Plantations

We have other methods for obtaining similar results, methods which are available in many cases, but have been worked out in only a few cases. Let us consider one specific example. During the war, Germany was successful in producing indiarubber in her chemical works. Converting into a works process the method for the polymerization of a hydrocarbon of low molecular weight to yield rubber, discovered as a laboratory operation by Tilden and Bouchardat many years ago, was a fine achievement, but there is no doubt that the cost of production was high.

When we consider, however, that many of the rubber plantations are in British territory, that curtailment of output has been necessary to keep last year's production down to about 350,000 tons—all the world could absorb—and that the cost of production was in the neighborhood of 25 cents per pound, it will be realized that the British Empire has a technical method for producing rubber which is a far sounder business proposition than the German synthetic processes.

Our raw materials result from rubber plantations, the establishment of which is not costly, the labor employed is cheap tropical labor, and the energy utilized is that of the sun's heat, which does not require to be mined and transported on railway trucks. Since the world's annual consumption of rubber will certainly increase rapidly, and since our rubber plantations already can produce more than the world's present requirements, it is clear that we are in possession of a process for making indiarubber, using cheap labor and gratuitous energy, which if conducted on scientific lines will always defy competition from the chemical works of Central Europe.

Synthetic Indigo vs. the Indigo Plantation

It would not be fair to deprecate the installation of synthetic methods for manufacturing complex natural products. Nature in general furnishes us with but one very complex member of any particular class of organic compounds. Thus, the numerous plants which produce indigo yield but minute proportions of other compounds of a similar type, and, in this instance, the chemical technologist has succeeded in manufacturing a whole range of valuable dyestuffs of the indigo family which do not occur among vegetable products.

His efforts have to this extent been amply justified,

but it is difficult to believe that synthetic indigo itself would ever have been able to compete in the market if a similar amount of scientific skill and intelligence had been devoted to the improvement of the cultivation and utilization of the indigo plant. The work which is now being done by Armstrong, Davis and others on natural indigo may well result in the re-establishment of the Indian indigo plantations which many decades ago brought such a substantial contribution to the financial prosperity of our Empire.

New Fields of Chemical Technology

The wider recognition of the fact that chemical technology largely neglects what perhaps should be regarded as its most important mode of operation may, at no distant time, be forced upon us as an entirely economic necessity. The densely populated temperate regions of our globe will demand for their consumption and dissipation ever-increasing quantities of energy, and the sources of energy in those regions—coal, oil, water power, etc.—are diminishing rapidly.

We shall be forced to set up a scheme for transporting to our northern countries the energy so lavishly sent from the sun to tropical lands. It is by no means impossible that the day may soon come when vegetable oils, produced in the tropics, will be brought northwards for use as an economical form of fuel.

With these considerations in view, it seems time for our chemical technologists to devote more attention than they have heretofore to practicable methods for utilizing the surplus energy of the tropics in supplementing the waning supplies of energy available in colder climates.

Refinement in Chemical Technology

Another aspect of this question forces itself upon us. The last century has witnessed two great phases in the development of practical chemical work. Roughly speaking, it may be said that the progress of chemistry up to about forty years ago, great though that progress was, resulted from the application of rather fierce methods. A time came, however, when it was recognized that much was to be learned, especially in organic chemistry, by the study of delicately balanced reactions in which the practical methods applied were devoid of violence and in which conditions, such as concentrations, temperatures, and the like, were carefully controlled.

The organic chemistry of to-day does not distill fragile organic compounds through red-hot tubes. It proceeds by more subtle methods which, nevertheless, have greatly developed the broad knowledge of the science bequeathed to us by our predecessors. In its adoption of milder modes of operating and its consequent application of energy at a low potential, organic chemistry is approximating in its laboratory methods those which occur in plants and animals; but the chemical changes which occur during the course of animal or vegetable life are still far more complex than those brought about in the laboratory.

This complexity doubtless arises from the utilization of low potential energy in the living organism; temperature changes of more than one degree Centigrade are not permissible in the healthy animal organism. The great majority of the chemical reactions which take place in living matter occur catalytically in colloidal media.

The Invitation to Bio-Chemistry

While the first great epoch in the history of organic chemistry was marked by the application of violent ex-

perimental methods, the second developed milder modes of procedure. The third epoch, which is in course of inauguration, will bring us into direct competition with the experimental chemical methods practised by living matter.

It is impossible to doubt that a vast expansion of organic chemistry will be witnessed by many of us, an expansion which will result from an imitation of the gently effected chemical operations carried out in the animal and vegetable creation.

While this prophecy is not a mere surmise as to the nature of the next step forward to be taken by the science of organic chemistry, but is rather of the nature of a logical deduction from past events, it is perhaps surprising that more use has not been made of the chemical methods of living matter, for technological purposes. On a technical scale, the activities of living organisms have been harnessed in the production of alcohol, acetone, glycerol, and acetic and citric acids from sugars, and the pathologist has been wonderfully successful in directing similar activities towards the rectification of abnormal vital processes.

Much also has been done in the bacterial treatment of sewage and the separation thereby of valuable plant foodstuffs from the very dilute solution in which these occur in effluents. When the immense variety of chemical operations performed by living material is considered, it must be concluded that the manufacturing processes just mentioned, important though they are, are but a minute fraction of those which could be economically applied to the production of useful organic compounds if the scientific study of the subject had been sufficiently developed.

This subject would seem to be of particular importance to the development of chemical technology in the British Empire, which includes within its domain every range of climate and every species of animal and vegetable life. If we were able to establish an organization for the study of methods and processes for the manufacture by biochemical agencies of useful chemical products we should reap a rich harvest.

Eradication of Parasites

Apart from questions of the desirability of plant culture for the purpose of increasing the yield of valuable products and of the study of biochemical methods for manufacturing necessary chemical substances, both of which are of vital interest to us, although perhaps of more purely academic interest to other nations, another problem presents itself to us.

A wide expanse of Empire brings with it exposure to a great variety of different types of parasitic life. These may be merely vegetable pests, like the prickly pear which is giving so much trouble in North Australia, or they may be such as cause diseases which render European life precarious in certain regions. The chemical technologist of to-morrow will need protection in the shape of methods for combating these ills, and up to the present far too little progress has been made in this direction.

It is true that the prickly pear is destroyed by spraying with arsenic chloride; but this is a mass treatment which is expensive, dangerous and only locally effective. It is true also that great success has been attained in the prevention or eradication of tropical diseases by inoculation with serum or by the injection of chemical materials. But notwithstanding the progress which has been made in these directions, the whole subject involved is but in its infancy; and although British institutions for the study of tropical diseases and of parasitic plants

have contributed much in comparison with their means, it cannot be denied that Germany also has done splendid service by the study in its state-supported institutions of the very vital problems which arise.

This source of scientific help will not be available in the future; it cannot be expected that a nation which only retains an academic interest in ills which no longer affect its own economy will preserve an active interest in fighting these tropical plagues. That the question is an urgent one—one which should interest our great manufacturers and merchants—finds illustration in the fact that over 90 per cent. of the inhabitants of the Fiji Islands and of Malaya are infected with hookworm; it would be difficult to estimate the extent to which production is limited by this plague in regions which are among the most fertile in the world.

Petroleum as a Chemical Raw Material

All the foregoing are questions which necessarily will become urgent at some no distant date, and most of them will call for the breaking of more or less new ground by the chemical technologist. Of others which seem to have been long ripe for study I may mention one.

Although we are in possession of very complete knowledge of the constituents of coal-tar, a very common raw material, and have developed an elaborately detailed scheme for utilizing those constituents in the manufacture of valuable chemical products, no real effort has yet been made to deal in a similar manner with crude petroleums. It is common knowledge that crude petroleums are very complex mixtures of organic substances, just as is coal-tar, and also that a great variety of mineral oils are available in large quantities, each quite different from the others in the chemical nature of the hydrocarbons of which it mainly consists.

No systematic attempt has yet been made to classify the various petroleums according to their chemical character, to separate from them pure chemical compounds, and to endeavor to utilize these in the chemical industries. So far as petroleum is concerned our present attitude resembles that which we maintained a century ago toward coal-tar; it is regarded as only fit to burn. A vast field of chemical activity lies before us in the scientific study of petroleums and the devising of processes for utilizing the valuable individual compounds.

Conclusion

I have ventured to lay before you a few thoughts concerning the manner in which the changed conditions of the world are likely to influence the future trend of development of chemical technology. Since no one can doubt that conditions are changed, I presume that all will agree that chemical industries, which depend upon these conditions will also change.

My own views may be erroneous, but their expression may be useful in emphasizing the urgent need that our leaders in industry and chemical technology should reflect upon the whole subject and formulate sound views as to the development of the organic chemical industries of the British Empire.

The General Chemical Co. will resume operation of two units of its sulphuric acid plant at Pulaski, Carroll Co., Va., closed since March. Pyrites mining will be resumed when surplus ore now on hand is used up. The company has made acid manufacture at this point successful by the disposition of the iron cinder to a local iron furnace, after roasting to procure the sulphur and nodulizing in rotary kilns.

Department of Commerce Charts of Business Conditions

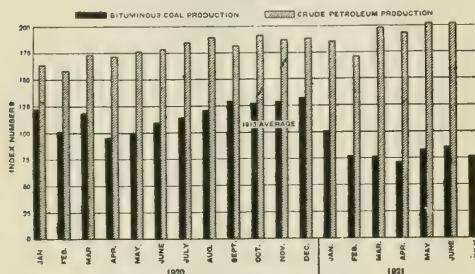
TO visualize the current trends of business and industry the Department of Commerce has begun the monthly presentation of condensed information, expressed also in charts, believing that it may be useful to the business public and that in some measure it will assist in the enlargement of business judgment.

To be of the greatest value such information must be widely diffused and digested by the business men of the country. It is not enough that the banks and the big business concerns should understand the trends in busi-

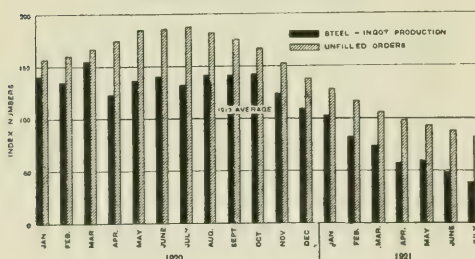
ness; the small manufacturer and the small dealer must have some understanding, too, so that there may be some semblance of unity in action.

To concentrate such a mass of information in convenient form and to make it useful for study and comparison, the data have been coded into relative figures, or index numbers, where necessary. These index numbers enable the reader to see at a glance the general upward or downward tendency of a movement, which cannot so easily be grasped from actual figures.

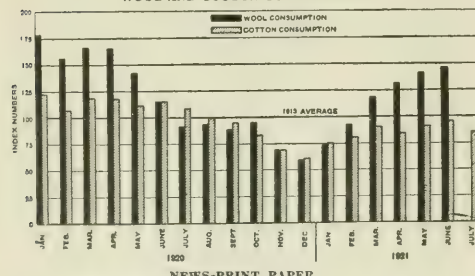
FUEL PRODUCTION.



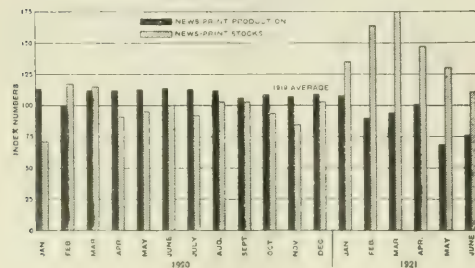
STEEL PRODUCTION AND ORDERS.



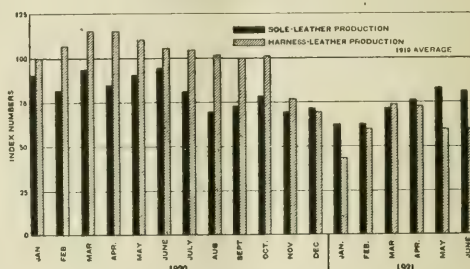
WOOL AND COTTON CONSUMPTION.



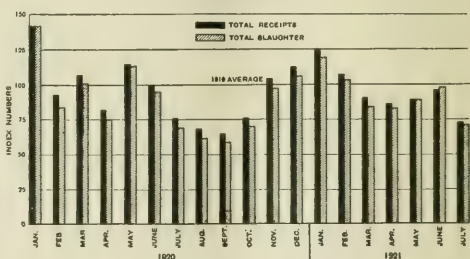
NEWS-PRINT PAPER.



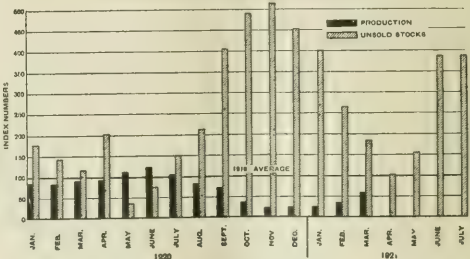
LEATHER PRODUCTION.



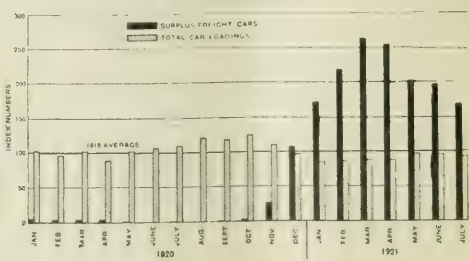
HOG MOVEMENT.



CONDENSED AND EVAPORATED MILK.



RAILROAD FREIGHT.



Improvement in Contact Process of Sulphuric Acid Manufacture

By Henry F. Merriam

General Chemical Company

THE new process is carried out in apparatus which is set forth diagrammatically in the accompanying drawing. In this drawing 3 represents the sulphur burner. This burner may consist of a Vesuvius burner suitably modified for the burning of sulphur under the conditions to be described. In this burner 3 a gas is formed which will, roughly speaking, be approximately an 8 per cent. SO_2 gas having a temperature of above $1,000^\circ \text{F}$.

For the purpose of this description the temperature of the gas leaving the burner will be indicated as $1,000^\circ \text{F}$. +. The air required to support combustion in the burner 3 and to form part of the gas therein is preferably dry and to that end the air is first passed through a drying tower 1 and is then conveyed by a Connersville or other positive pressure type of blower or fan 2 into the burner 3. The hot gases from the burner 3 are passed through air-cooled pipes constituting the cooler 4 by virtue of which the temperature of the gases is somewhat reduced but is nevertheless conserved at approximately 750°F . under conditions where hazardous condensation of sulphuric acid, when present, is minimized.

Catalysis

From the cooler 4 the gases still retaining their original heat to the extent of 750°F . enter the converter or contact chamber 5, wherein the mixed SO_2 and air passing over or through platinum contact material is partially converted into SO_3 . Considerable heat is generated in this converter 5 and the gases leaving it have a temperature of approximately $1,050^\circ \text{F}$. The gases, now consisting of SO_3 , SO_2 and air, pass through a cooler 6 of the same general type and construction as cooler 4 but of sufficient capacity to bring the temperature of the gases down to about 750°F ., at which temperature they enter a second converter 7.

In the second converter 7 the conversion of SO_2 to SO_3 is practically completed so that as the gases emerge therefrom 97-98 per cent. conversion has taken place. The temperature of the gases at this point, *i. e.* where they leave converter 7, is about 830°F . The cooler 8, similar to cooler 6, reduces the temperature to between 400 - 500°F ., at which temperature the gases are conducted into the absorber 9, of well-known construction, and the SO_3 absorbed, the sulphuric acid being continuously withdrawn from absorber 9 as produced.

Maintenance of Original Temperature

It will be observed from the foregoing description that during the entire progress of the gases from the time they leave the sulphur burner 3 to the time that they enter the absorber, their temperature is conserved and maintained, the gas at no point of its travel being reduced in temperature to a point lower than the tem-

perature required for the next operation. In other words, the gases are never at any point permitted to become cool so as to require any substantial artificial reheating to bring them into proper condition for the further treatments. There is, consequently, no counter-current of the material operated on, which greatly simplifies the structure of the apparatus.

The heat changes necessary in this process* are all to the end of reducing temperatures and not of raising temperatures. This simplifies construction, etc. The avoidance of radical fluctuations of temperatures means that no work once accomplished requires to be undone and also that no work which is to be done requires intense auxiliary influences.

The gases being maintained from the sulphur burner through to the end of the last conversion at temperatures approximating but never materially receding from the temperatures involved in the original creation of the SO_2 gas mixture, it will be apparent that the gas under treatment is, throughout, substantially in the same condition as when formed in the first instance, *i. e.* there is no great contraction followed by great expansion and no changes of a physical or chemical nature which might be attendant upon such fluctuations of condition as would be represented by sharp contraction of temperature followed by a raising of said temperature. For example, sulphuric acid which might be developed, if any, would at all times be prevented from condensing and the apparatus be, in consequence, preserved against attack.

Temperature Regulation Obviates Necessity of Purification of Gases to Prevent Poisoning of Catalyst

It heretofore has been considered essential that upon the creation of the SO_2 gas that said gas be purified not only of arsenic but of many other ingredients, such as sulphuric acid in the form of a suspended mist and other sulphural or mercurial impurities. This has been true no matter what material was used as the source of sulphur. One of the most important discoveries in this art has been that which deals with the necessity of purifying the SO_2 gases so as to prevent them from poisoning the platinum contact material.

Even when the practically pure sulphur was used as the source of SO_2 , it has been deemed necessary and essential to purify the gases and particularly to remove therefrom sulphural impurities. The removal of these impurities invariably involves a reduction of the temperature of the gases so that the same, after being purified, require a reheating to bring them up to the temperature required for conversion in the contact chambers.

I have now discovered that provided the temperature of the SO_2 gases as they leave the sulphur burner are protected against material lowering of their temperature

*Letters Patent 1,384,566, issued July 12, 1921

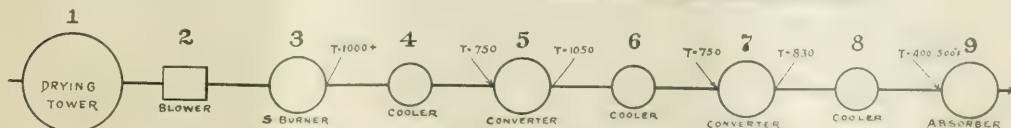


Diagram of Contact Process of Sulphuric Acid Manufacture

followed by a material raising thereof, satisfactory conversion can be obtained without poisoning the contact material and without destroying the apparatus and with an efficiency equal to that of the standard process but at much less expense provided further that a certain type of sulphur is used in the burner.

Louisiana Sulphur

As illustrative of the type of sulphur which satisfies the conditions, reference is made to Louisiana brimstone and its equivalents, Union, Freeport or Texas sulphur. This material, although containing small percentages of arsenic (As_2O_3), when treated in accordance with the process described and under the conditions of avoiding special purification which the described process implies, does not result in poisoning the contact material in the converters. In some of the tests which were conducted no arsenic was found in the contact material by the most refined methods, although had the full amount of the arsenic present been retained by the contact material, it would have been very easy to detect.

The precise reason why Louisiana brimstone, when treated as described, does not result in the poisoning of the contact material, cannot be definitely set down, but it may be the fact that the percentage of arsenic in the raw material being relatively small is to a large extent retained in the ash without being volatilized, while that proportion which is volatilized, being preserved against reduction of temperature, passes through the contact material in a condition in which it does not injure it.

Perhaps the degree of its dilution may in part account for the failure of the arsenic to act as a material factor in the poisoning of the contact material. Whatever may be the true reason therefore, the fact is that when the source of sulphur is of the Louisiana brimstone type and the operations are conducted according to the process described, no material poisoning of the contact material takes place.

The sulphuric acid mist, also recognized as a contact poison, ceases to be a factor since the temperatures of the gases are throughout kept above the condensing point of sulphuric acid. The sulphur vapor which often acts as a carrier for arsenic seems, under the special conditions of the new process, to either relinquish this function or to exercise it in a manner which is not injurious.

Heat Conservation

The heat of combustion which in prior processes was sacrificed, is now conserved, only so much of it being lost as is needed to reduce the temperatures to those required in the converters. No raising of the temperatures, which is the wasteful part of any operation, is required. By means of this process the use of the elaborate purifying apparatus heretofore described as necessary when using Louisiana brimstone as the sulphur dioxide source is wholly avoided. Under certain conditions, particularly faulty operation of the burner, it may be advisable to interpose a filtering device in the gas path prior to entry into the converter to remove mechanical dust.

The practice of the process described may, of course, within reasonable limits, be modified by occasional reduction of temperature at various points, such temperature losses being substantially compensated for by proper heat addition.

I intend to cover such variants of the process described, it being understood that when I speak of maintaining the temperature or of preventing the temperature from falling below certain limits, I mean to exclude that kind of temperature diminution which is characteristic of the purification processes now generally em-

ployed. So long as a substantial and material amount of the original heat of the gases, *i. e.*, a heat approximating or, at least, not greatly deviating from the temperature required for catalysis is conserved and carried through until 97-98 per cent. conversion is achieved, the process falls within the intended scope of my improvement.

Customs Experts Favor American Valuation

Editor, CHEMICAL AGE:

One of the arguments of the opponents of American valuation is that the experts are strongly opposed to the plan. A glance at the reports of the hearings held in Washington will show that a number of Treasury experts indorsed the change from foreign to domestic valuation.

Nathaniel Van Doren, customs agent of the United States Treasury Department, told the finance committee: "I believe that we could get domestic values in a much more satisfactory manner after it (American valuation) is once established." George P. Lamb, special attorney of the division of customs of the Department of Justice, testified:

"I am in favor of it. It would compel countries in which the cost of labor is low to pay the same amount of duty on importations of similar merchandise that countries having higher labor costs would pay. It would also do away with the irritation caused in foreign countries by the investigations made by our special agents. That was exemplified in France in connection with the Limoges investigation and in Germany—I believe our special agent was ordered out of Germany. I think it would do away with closed markets, like Limoges, St. Gall and Nottingham, where, as a matter of fact, we know very little of what the costs were and information was refused. Again, I think it would prevent under-valuation."

Another expert whose testimony seems to have been overlooked is Chares D. Lawrence, also of the division of customs of the Department of Justice. Mr. Lawrence testified before the finance committee as follows:

"Instead of seeking out the markets of the world in order to find values, as we are doing today, why would it not be a much simpler, more efficient, scientific and accurate method to find the value of all imported commodities where such values may be found at first hand, and if the information or the evidence cannot be obtained by voluntary contribution its production can be secured by judicial process, as those in possession of it are amenable to our laws?"

Also please note the following sentence from the Tariff Commission's report on American valuation:

"Everything considered, nothing short of complete abandonment of foreign sources of valuation would appear to obviate the difficulties incident to reliance upon invoices, variance between foreign consumption values and export prices, instability of exchange and differences in cost of production in foreign countries, which make a change in the basis highly desirable."

RICHARD J. SIMMONS.

California yields commercially a greater number and variety of mineral products than any other state in the United States, and probably more than any other equal area elsewhere of the earth. Previous to 1916, the total annual value of her output was surpassed by but four other states, they being the great coal and iron producers of east of the Mississippi River. In 1916 and 1917, because of their enormous increases in copper output, Montana and Arizona passed California in total value of those years; and Arizona for 1918. Of one item, at least, borax, California, still remains the sole producer; and for many years was also the sole domestic source of chromite and magnesite. California produces at least 75 per cent. of the quicksilver of the United States. For some years it has been leading all others in gold and platinum; while alternating in the lead with Colorado in tungsten, and with Oklahoma in petroleum.

Standardization of Paints and Varnishes

By F. P. Ingalls

Chief Chemist, John W. Masury & Son

THE ideal paint or varnish specifications cannot actually be written until the sum total of our chemical and physical knowledge shall reach the infinite, yet it is wholly rational to discuss such an ideal, and, by overcoming obstacles one after another, try to approach, in practice, ever nearer to it.

Specification Defined

Although the larger part of the paint and varnish sold in this country is purchased ultimately by a large number of relatively small consumers, without any specification other than is implied by the brand or assurance of the manufacturer, there are many buyers who by virtue of some obligation to purchase at the lowest rates or to avoid favoritism in awarding contracts, must accept the lowest obtainable quotations for satisfactory goods. Under such circumstances it is obviously necessary for the buyer to state in clear and unmistakable terms just what goods will be satisfactory or acceptable and at the same time exclude all other or inferior goods. Such a description is called a specification.

The most nearly perfect specification is that one which, in the fewest words, best describes the desired paint or varnish so clearly and completely that no inferior product can gain acceptance. The ability to write any such specification not only involves a general knowledge of the possibilities of production from such materials and by such methods as are known to be available, but it also implies the existence of ways and means of determining the probable economic value of the delivered goods before they are put into actual service. In other words, the specification must be based on a knowledge of what can be produced, and how to test the delivered goods. This is fairly evident, because in any exchange of goods for money or other value the delivered goods must in general be accepted and paid for long before they shall have demonstrated their value in actual service.*

American Society for Testing Materials

It is scarcely to be expected that any one person can have at his command all the knowledge necessary for the best possible specification, nor that a specification which embodies only the knowledge of one person, however expert, will be universally acceptable. In this country, however, we are fortunate in having at our disposal the collective knowledge and co-operative work of Committee D-1 of the American Society for Testing Materials, a committee numbering about 115 members composed of the leading paint and varnish technical experts, producers and consumers both having about equal representation.

The A. S. T. M. is a permanent organization of

about 3,000 engineers and technical experts. Its prime object is to prepare specifications and to define standards for engineering materials of all kinds. Any specification issuing from such a body may be regarded as highly authoritative. A number of other bodies are

closely allied with it, especially the U. S. Government Inter-departmental Paint Specification Committee, the Paint Manufacturers' Association of the U. S., and the National Varnish Manufacturers' Association, all of which have direct representation on Committee D-1.

With all this aggregation of talent, operative for a number of years past, it is pertinent to ask: Why are so few complete and satisfactory specifications for paint and varnish available at the present time? The answer to this question brings before us a realization of the really formidable array of obstacles encountered, and the large amount of slow, tedious and painstaking work required to overcome them.

Paint Defined and Classified

Theoretically paint is a very simple thing. It is merely a solid-liquid two-phase physical system composed of any finely divided, essentially inert powder or pigment, suspended in a liquid vehicle which possesses the property of becoming solid upon extensive exposure to the air. In detail, however, it is no such simple thing, but is a highly complicated affair with almost infinite possibilities.

The complete list of products of any of our larger manufacturers will show all the way from 300 to 600 or more items, each regularly carried in stock ready for delivery to the purchaser. In addition to these there may be several thousand formulas for special paints or varnishes of one kind or another especially adapted to some unusual or peculiar use. Fortunately these items, although distinct in themselves, may be divided or classified into about fifteen or twenty groups, or lines, of paints and half a dozen classes of varnish, the individuals of each class differing from one another merely in some minor detail, such for instance as color.

In a system of classification the difference between the individuals would be determined generally by the pigment present, but the classes would be distinguished by the character and proportion of the vehicle. Paints are therefore usually divided into two grand divisions—namely, paste paints, which require thinning down for use, and liquid, or ready-mixed, paints, which are already thinned down and are practically ready for use.

In the first division the proportion of vehicle is as small as is practicable for the grinding process, while in the second division the proportion of vehicle is much larger and is adjusted so as to give the finished paint the required working properties under application. In both divisions the classification rests almost wholly on



F. P. INGALLS
Chief Chemist, John W. Masury & Son

*Presented at Paint and Varnish Symposium, September 15, Seventh National Exposition of Chemical Industries.

the quantity of vehicle present and not at all on the character of the pigment.

Although it is desirable that we should have good specifications for paste paints as well as for liquid paints, yet, inasmuch as the paste paints must in general be thinned down before use and in this process may be diverted into any one of several different subdivisions of the liquid paints, according to the character of the thinning liquid, it is only natural that the greater interest should center in the finished paints themselves, and it is these finished paints which not only command the greater interest but also present the greatest obstacles to standardization and specification.

The Pigment

In theory the pigment of a paint is supposed to be essentially inert chemically as regards the vehicle, the paint being a plain mechanical mixture of finely powdered pigment with a more or less viscous liquid. In the majority of paints, however, this condition is not immediately realized, because nearly all of the available vehicles contain organic acids in varying degree and kind, and many of the pigments are basic in character, some of them highly so.

Under these circumstances a certain amount of chemical reactivity is to be expected, especially under the frictional heat of grinding. From the purely scientific standpoint this does not impair the validity of the theory, for if the new substances formed by the reaction are soluble in the remaining unaffected vehicle, then they become a part of the liquid phase, and if they are insoluble they become a part of the solid phase, so that finally we have a pigment and vehicle which can no longer react with each other.

The important point to be considered here is that the resultant paint may, and generally does, have notably different properties from what it would have shown had there been no reaction; furthermore, sometimes these differences may be advantageous and at other times disadvantageous.

In most cases the pigment and vehicle are so chosen that the reactivity shall be relatively very small and fairly constant, but if not so chosen and if the reaction becomes extensive, either at once or during a considerable time, then the paint generally becomes useless, especially on storage. These, however, are not the only complications due to the pigment.

Aside from anything which may be traced directly to chemical reactivity the pigment may have a profound influence in other ways for which, up to the present, there is no tenable and comprehensive theory. Such influence may best be shown by citing illustrative cases.

Good raw linseed oil exposed in a thin film will dry in five or six days at ordinary room temperature. The same oil after the introduction of dryers may be made to dry in seven or eight hours under the same conditions; such an oil is readily obtainable commercially as "boiled" oil and in the trade is a fairly definite product. There are several hundred pigments in common use representing about forty or fifty different types or kinds which differ widely both chemically and physically. When these are ground into paste paints with either raw or boiled oil we notice that while the drying time of the oil remains unchanged in some cases there are other cases in which it is accelerated and still others in which it is retarded. We shall quote only a few of the extreme cases.

Influence of Pigment

Upon Drying Properties of Paint

Knowing, as we do, that small quantities of certain

metals such as lead, manganese, cobalt, iron and a few others have a pronounced catalytic effect in accelerating the oxidation of oil, we are not particularly surprised to find that such pigments as white leads and umbers accelerate the drying speed, nor is it necessary to postulate anything further than a slight chemical reaction between pigment and vehicle to account for the acceleration.

No such explanation, however, will account for the great retardation induced by such pigments as vandyke brown, various carbon blacks and certain coal-tar dye lakes made by precipitating basic dyes with tannin.

Carbon Black

It is difficult to imagine a pigment more inert chemically than the carbon black made by burning natural gas, and when ground in boiled oil it makes a good practicable paste with about 12 lb. of black to 88 lb. of oil. Good carbon black gives an ash of less than 0.1 per cent and contains occluded air sometimes to the extent of several per cent, but whether or not this occluded air is wholly displaced by oil in the ground paste, it is quite certain that any effect which either the air or the trace of mineral matter might have would be accelerative rather than retardant.

Whatever might be expected as to the drying speed of such a paste paint, the fact is that 12-15 days are required instead of the seven or eight hours required for the oil alone. If the drying time were retarded to only five or six days, it might be explained on the assumption that the metallic dryers are absorbed by the finely divided carbon and their catalytic effect suppressed, but when the paint requires six or eight days more than raw oil itself, no such assumption is tenable.

The different blacks owing their color to carbon do not all show the same degree of retardation, but no sort of chemical analysis reveals any sufficient reason for the observed differences. The most extreme case of retardation coming under the writer's notice was a "tannin-methyl violet" lake ground in raw oil; it did not dry in five months, and even when it could finally be touched was a gummy mess wholly unlike a good paint film. Fortunately lakes of this kind are unimportant, because better ones can be made, and at best they are too fugitive in color for general use, but the case is of considerable academic interest.

Influence of Pigment

Upon Durability of Paint

Pigments also differ widely in their influence on the durability of paints made from them. This is especially important in exterior paints, or common outside house-paints well known and familiar to almost everybody.

Whether this influence is a direct result of the same fundamental principle that affects the drying speed or not is open to question, but there is apparently some close connection, because long experience shows that some of those pigments which exhibit the greatest retardation also have the greatest influence in delaying the decay of the vehicle in service.

Other factors probably enter, for it long has been known empirically that if small quantities of colored pigment be added to any given base white paint, the tinted paints so made will outwear the original white, and the hiding power is also increased to a much greater extent than would be expected from such a small quantity of color.

Measurement of Hiding Power

A small instrument devised by Dr. Pfund of Johns Hopkins University allows us to measure this hiding power. In a research bulletin issued from the laboratory of the New Jersey Zinc Co. on Aug. 1 of this year

some results obtained by Dr. Pfund are set forth in detail.

Among these results he shows that in a certain paint made from zinc oxide the addition of a very small quantity of lampblack raised the hiding power of the paint from 145 for the straight white to 486 for the light pearl gray tint, these figures expressing the hiding power in terms of square feet of black surface completely hidden by one gallon of paint. The proportion of lampblack required for such a tint is not more, and generally less, than one-tenth of one per cent on the zinc present—a quantity apparently out of all proportion to such a result.

Kauri Reduction Test

It always has been held that finishing varnishes which are required to withstand exterior exposure should always be "long in oil" and that elasticity and durability were accompanying features more or less in direct proportion. After thorough drying, short-oil varnishes crack readily when sharply bent, and therefore if we add more gum to a long-oil varnish until it cracks when bent we have a measure of the "length" of oil, and consequently the probable durability.

This test is the so-called Kauri reduction test and for the detailed method of carrying it out we must refer you to the latest Inter-departmental specification for spar varnish. Whatever the further development of this test may show, it is founded on many years of solid experience, and while its results may not run exactly parallel to the service tests in all cases, yet as a test it is less liable to error than the service tests themselves unless the latter are carried out with most unusual care.

For some time yet it may still be desirable to include in varnish specifications the composition desired so far as that composition can be determined by analysis with reasonable accuracy, but by specifying what the varnish shall *do* and expressing it in terms which our present knowledge can measure quantitatively we are taking a long step ahead.

Future of Specifications Research

During the past five or six years in which the attack has been active from the physical side much more progress has been made than in any previous similar period. Work is now under way which we hope will result in an accelerated test for durability in paints, and if this hope is realized the future is rosy with the optimistic expectation that, while we may not indeed reach the ideal, yet, for the first time in the history of the industry, we shall be able to standardize with reasonable accuracy the more important types of both paint and varnish, and write specifications which will be rational, sound and useful.

If any such demonstrable resistance to the passage of the visual rays of light follows the introduction of such small amounts of color, it is highly probable that the actinic rays are also obstructed and their influence in hastening the decay of the vehicle considerably diminished. This seems to be the most reasonable hypothesis, for it is fairly certain that actinism and water are the most potent causes of decay in exterior paints.

Whether paints be regarded as merely decorative or protective, or both, their durability as an economic factor is of paramount importance. No extended argument is necessary to carry conviction on this point for, on the average, it is fair to say that three dollars' worth of labor will be required to apply one dollar's worth of paint. The initial cost of the paint is to be considered, of course, but the real measure of value is the con-

sumer's ultimate cost for continued upkeep, including the labor charges. Ultimate economy is clearly dependent upon the durability of the paint.

Influence of Fineness of Division of the Pigment

One other important influence of the pigment must be noted, and that is the effect due to the mere size and shape of the particles. Mixtures of pigments with any paint vehicle do not take on the physical properties characteristic of good paint until the particles present a relatively large specific surface to the liquid vehicle.

Roughly speaking, the particle diameter may range from 0.2 micron to 50 microns with a mean average of 5 to 20 microns. When pigments are reduced by any process of mechanical grinding, the particles are far from uniform in size and if the material is subject to cleavage, the diameter in one direction may be much larger than in another, so that in stating average size we do not give a full idea of the physical state. It makes a great deal of difference whether there is a wide range between the maximum and minimum size, or whether the particles are more nearly uniform.

The important point to us now is that as the particles become finer the tendency to flocculation increases, and, unless counteracted by the dispersive power of the vehicle, all sorts of changes in the consistency and applicability of the paint may ensue. However interesting the further discussion of this phase of the subject might be, we are concerned here only with the relation of such effects to the preparation of specifications, and enough has been said to show that they alone would render difficult the full description of a paint by merely specifying the ingredients and their proportions.

The Vehicle

Whatever the difficulties arising from the pigment, those arising from the vehicle are quite as great. There is no practical vehicle composed of a single unitary substance of fixed properties, and rarely if ever is the vehicle of a finished paint composed wholly of any one of the drying oils in its original state. Almost invariably metallic dryers must be added, and while our knowledge of some of them is satisfactory, we know much less about those which have been prepared by the various cooking processes in common practice.

Even linseed oil itself comes to the paint manufacturer in no fewer than five types—viz., raw, refined, boiled, bodied and blown—all in daily use, and when we consider the cooked and uncooked mixtures of the various drying oils with other substances whose chemistry is even less definitely known, we are forced to realize the essential hopelessness of attempting to describe them in terms of composition.

Essential Properties of Paint

If then such obstacles to full specification by composition are interposed by both pigment and vehicle, what are we to do? The answer to this question is easy, but the preparation of a good specification founded on this answer is more difficult. If we consider paint from the consumer's standpoint the composition is of no great moment except in so far as the presence or absence of some particular ingredient positively adds to, or detracts from, the economic value of the paint.

The consumer buys paint for what it will *do* and if he can rely upon a definite performance in service his further interest is perfunctory. We may write a good specification therefore by stating what the paint shall do, knowing of course that such a paint can be made. The only real obstacle to this procedure is that we have no trustworthy test that will indicate with reasonable certainty the probable durability of the paint in service.

Experience shows that the value of paint rests chiefly on five main properties—namely, color, degree of gloss, hiding power, working properties and durability, all physical attributes. All these, except durability, are susceptible of quantitative measurement, and if we could measure durability, we could determine the economic value of such paints without knowing anything about their composition.

Chemical Basis of Paint Specifications Insufficient

When Committee D-1 first began its systematic study of paints it quite naturally attacked the problem from the chemical side on the reasonable assumption that if the composition were fixed the physical properties must also be fixed. Some of the reasons why such a method can be only partly successful have been given above in considerable detail.

The committee soon realized that the subject was complicated, and in order to simplify matters confined its attention for some years chiefly to one type of white paints. On the Arlington test fence alone some 240 white paints were tested out in which the differences were due chiefly to changes in the proportions of the more common white pigments while the vehicle was maintained as nearly constant as possible.

Supplementary tests of a similar kind were carried out, literally in thousands, by individual interests, but in spite of every care and an enormous amount of work, the knowledge derived has not been considered enough to serve for a satisfactory specification. The more re-

cent efforts therefore have been directed more toward a study of the important physical properties, and the present tendency is to demand certain physical properties in a quantitative degree, putting up to the manufacturer the problem of how to get them in.

Varnishes

Specifying varnishes by composition has met with the same obstacles that pertain to paint. Until very recent times the attack has been from the chemical side despite the fact that our chemical knowledge of even the raw materials involved is incomplete, meager, and sometimes even no more than speculative. Varnish is simpler than paint in that there are no complications due to pigment, but when two problems are both beyond our capacity to solve, it makes little difference which is the more complex.

During the war large quantities of varnish of maximum durability were required and there was great need for some test which would give some indication of the durability of the many brands offered. Under the stimulus of this pressure a method of test was developed from an idea that has been regarded as axiomatic in the varnish industry for generations.

No gum-and-oil varnish yet made has anything like the durability of a first-class linseed oil paint in which the vehicle is practically all linseed oil with only the minimum proportion of dryers, and as the proportion of gum in varnish increases, the elasticity and durability are diminished.

Production of Transparent Emulsions

By Thomas M. Rector

Musher & Co., Inc.

SUMPTUARY legislation represented by the XVIII Amendment has compelled a revolution in chemical processes of condiment manufacture involving the use of alcohol, particularly in the production of flavoring extracts.

The elimination of alcohol has compelled the solution of the problem of producing a transparent or translucent emulsion of the essential ingredient heretofore marketed with ethanol as the vehicle. To do this requires treating two or more immiscible substances as oil and water to bring their refractive indices to the same point before mixing whereby when they are emulsified a transparent or translucent mixture will result, the degree of transparency being controlled by the similarity of the refractive indices of the different materials.

As an example, two common immiscible substances are water and oil. After the usual emulsification of water and oil is effected, the resultant emulsion is of opaque nature, and as an illustration, the medicine known as Scott's Cod Liver Emulsion is a thick white creamy substance including therein oil of the cod fish liver and water with the emulsifying agents, thus producing a substance that is opaque.

The present improved process* consists in treating one of the substances whereby the oil and water have similar refractive indices. This step in the process may be accomplished by adding salt, sugar or other water-soluble material to the water after which the oil and treated water are mixed in the presence of an emulsifying agent to produce a transparent or translucent emulsion.

The degree of transparency is controlled by the similarity between the refractive indices of the different substances, as, where there is slight variance in the refractive indices of the two immiscible substances, the emulsion will be more translucent than transparent.

The above method may be employed with any number of immiscible substances, the idea being to transform the substances by the addition thereto of material soluble therein for bringing the refractive indices of the different substances to the same point, whereby the different materials when emulsified with the addition of any ordinary emulsifying agent produce the effect of a transparent or translucent solution.

Du Pont Administrative Changes

Peace-time adjustment of the industries of the E. I. du Pont de Nemours & Co. has involved the following changes in administrative personnel:

Vice Presidents A. Felix du Pont, J. B. D. Edge, Charles A. Patterson and C. A. Meade have resigned from the Executive Committee. Vice Presidents H. F. Brown and F. G. Tallman have resigned from the Finance Committee and are now members of the Executive Committee. R. R. M. Carpenter, another vice-president, has resigned from the Finance Committee to become general manager of the cellulose products department; William P. Allen will be his assistant.

The other general managers are C. A. Patterson, in charge of explosives, with A. Felix du Pont and J. Thompson Brown as assistants; Charles A. Meade, in charge of dyestuffs, with W. F. Harrington as assistant; Hunter Grubb, in charge of paints, with E. C. Thompson as assistant, and C. W. Phellis in charge of pyrolin, with A. F. Porter as assistant.

There are six auxiliary departments created to act in a consulting capacity and also as a staff to serve the company as a whole. These are: Legal, J. P. Laffey, chief counsel; development, Finn Spare, director; engineering, S. M. Pierce, chief engineer; chemistry, Dr. C. L. Reese, director; service, W. B. Foster, director; and advertising, C. F. Brown, director.

*U. S. Letters Patent 1,380,161, issued August 30, 1921.

An Improvement in Evaporator Design

By Robert V. Cook

Chemical Engineer, Chemical Equipment Co.

THE universality in industry of the process of evaporation, which connotes distillation, imparts to any innovation in evaporator design the interest incident to a change of style in personal adornment, with the added factor that such change in industrial procedure or equipment expresses the never-ending search for increased efficiency.

This improved efficiency in evaporator design and operation has its reflex in greater fuel economy, or higher quality of product or both, which are the activating causes of improvement. It is natural for evaporator builders and users to consider present types as standard, for what has acquired a vested character as a rule can be changed only by those not wedded to such material considerations. Horizontal and vertical tube-types of evaporators have their respective advantages and deficiencies. If we can combine the former and eliminate the latter in a new type, it is obvious that a worthwhile improvement has been made in the equipment and operation of a common chemical process.

Evaporation in chemical manufacture is the removal of solvent from the dissolved substance by means of heat, for our purpose carried by the vehicle steam. It is essential to the full utilization of the heat carrier that every particle have the closest contact with the material to be heated that there may be yielded to it the maximum number of heat units in the shortest time, and further that this intimacy of contact contribute to greater ease of operation. Horizontal-tube design is inseparable (1) from sagging interfering with steam circulation; (2) difficulty of quick drainage of water of condensation; (3) sluggish circulation of the liquor to be evaporated; (4) annoyance in cleaning tubes; (5) unsatisfactory introduction of fresh liquor.

Vertical-tube design does not permit contact with the tube wall of all portions of the circulating steam; the tubes must be large to prevent clogging and to facilitate removal of collected solids; they are difficult to replace, owing to the type of construction. In this type steam surrounds the tube through which passes the liquor to be evaporated, while in the horizontal type the reverse is true.

In the interior view, Fig. 1, is shown the novel tube arrangement and the circulation of steam and liquid in an evaporator which represents a distinct step in the evolution of the evaporator design. In this particular evaporator there are ninety-six $\frac{1}{2}$ -in. seamless drawn copper tubes, 32 in. long, giving 33.5 sq. ft. of heating surface. They are arranged in two groups, half being inclined downward toward the right and half inclined downward toward the left, the rows being staggered, as shown. The front (left) steam chest is divided in the middle by a horizontal partition which compels

the steam to descend the tubes inclined to the bottom of the back (right) steam chest. Continuous separation of condensed steam from the bottom of both front and back chests is provided, as shown.

The criss-crossing of the steam tubes, which gives the design its name, intensifies the heat at the cross and thereby compels the rapid circulation of the liquid to be evaporated, which is a prime requirement of a high evaporative factor. The boiling up on each end is due to the rapid heat transfer which takes place when the steam first enters the tubes, as in all other evaporators. The difference is that in the present type the water boils up on both ends instead of one, for the steam is entering the tubes at both ends.

The very rapid circulation of liquid throughout the liquor chamber not only increases the evaporative factor, but decreases very materially the tendency to form scale on the outside of the heating tubes. The liquor circulation admits of easy control either by varying the angle between the tubes thus changing the center of heat intensity, or by removing or inserting tubes thus changing the proportion of heating surface to the volume of liquid.

Rapid and unobstructed circulation of steam is assured by inclining the tubes. Condensation at the upper end, where it is at the maximum, under the influence of its own density and the steam pressure, passes immediately to the bottom of the steam chest to be trapped-out, thus providing conditions for the most efficient transfer of heat. Sagging, common to the horizontal-tube type, is obviously without influence here on perfect drainage. Furthermore, the use of shorter tubes of smaller diameter, all easily accessible and replaceable, contributes to a higher evaporative factor.

The higher evaporative factor is expressed in the use of a smaller machine for a given duty than if a standard evaporator were used, as is shown in the following table of comparative results.

Factor Compared	Horizontal Tube Evaporator	Criss- Cross Evaporator	Comparison Stated as a Ratio
Capacity in gallons per hour when evaporating water	240	259.2	Approx. 1:1
Square feet heating surface	180	33.5	4:1
Overall dimensions	3 ft. 6 in. x 9 ft. 6 in. x 7 ft. 2 in.	3 ft. 6 in. x 3 ft. 7 in. x 8 ft. 0 in.	
Cubic feet occupied	237.7	98.0	24:1
Floor space occupied in square feet	3125	12.25	27:1
Weight in pounds	1100	280	4:1

The removal of solid matter is provided for by the manholes opening into the large space beneath the tubes. The introduction of fresh liquor is by means of a cast-



ROBERT V. COOK
CHEMICAL ENGINEER
Chemical Equipment Company

iron trough located beneath the point of greatest heat intensity whereby the cold liquor is taken up immediately by the convection currents and without their disturbance, as is common with present types. More efficient introduction of cold, fresh liquor is not possible.

In many chemical plants in these days of close competition and small margins, the attributes of the evaporator used often may mean the difference between profit and loss.

In concluding this description of an improved type of evaporator we may add that the successful application of the criss-cross tubes in this form of equipment demonstrates their equal suitability for surface condensers, coolers, pre-heaters, boilers, and for all forms of heat exchange apparatus. The improved pre-heater would be much like the evaporator in arrangement, operation and advantages.

The surface condenser is also very similar to the evaporator. I have found that this new tube arrangement so facilitates condensation of vapors that they can be passed downward inside the tube as the steam

tubes cross, so the circulation would be very comparable to that in the criss-cross evaporator. This new tube arrangement then hold many promises for the future.

Salesmen's Association of the American Chemical Industry

MEN who sell the products of chemical enterprise and who, by their knowledge of consumption demands, determine the production policy of the chemical plant, and who, by their close proximity to income and profits, outrank the works' chemist in their influence as factors in the organization, met in inaugural session on September 7 at the Chemists' Club, New York, of the Salesmen's Association of the American Chemical Industry, at which the organization was launched with 97 charter members.

The following officers were elected unanimously: President, Burton T. Bush, Antoine Chiris Co.; vice-presidents, Francis L. McCartney, Monsanto Chemical Works; Theodore R. L. Loud, N. Y. Quinine & Chemical Co., and Chas. B. Hall, Cleveland Cliffs Iron Co.; secretary, William Haynes; treasurer, A. A. Wasserscheid, Mallinckrodt Chemical Works.

President Burton T. Bush discussed the service of an organization of chemical salesmen to the chemical industry and emphasized the important part played by distributors in the development of the industry. He said:

"I should like to meet an executive who today is not, to quote from the proposed constitution, 'directly engaged in sales promotion work,' and I can see where American chemical salesmen, banded together, can cooperate to make better and more effective the selling conditions that exist in all branches of our industry. Our chemists in their research work, our executives in their managerial problems know that the net results of their thought and work are translated into dollars by the sales forces. And when two thousand American chemical salesmen organized in this association speak, their voice carries far."

Membership is active and honorary, the former embracing salesmen, sales managers, sales agents, advertising managers, executive officers engaged in sales or sales promotion of an American chemical manufacturer, and representatives of the chemical trade press, and the latter those who have rendered distinguished commercial service to the American chemical industry.

At the dinner given by the association on September 16 at the Eighth Coast Artillery Armory, during the Chemical Exposition, 200 salesmen from the various branches of chemical industry attended.

The Salesmen's Association of the American Chemical Industry is an organization of business chemists to whose alertness and to whose appreciation of the advantages of organized study of common problems production chemists well can give heed. Salesmanship is a profession in which field exists the freest play of natural capacity and its quickest recognition. The problem is to move goods at a price that will co-ordinate consumption and production.

That production chemists in whose hands the ramifying sequences of industry start is the only unorganized professional element in the business and art of chemistry is not so much a reflection upon the characteristics of the chemist as it is upon the deficient practical vision of self-constituted leaders of chemical opinion.

This ulterior conservatism will be surmounted eventually by the organization of an economic society devoted to the recognition of the professional status of chemically educated men in industry.

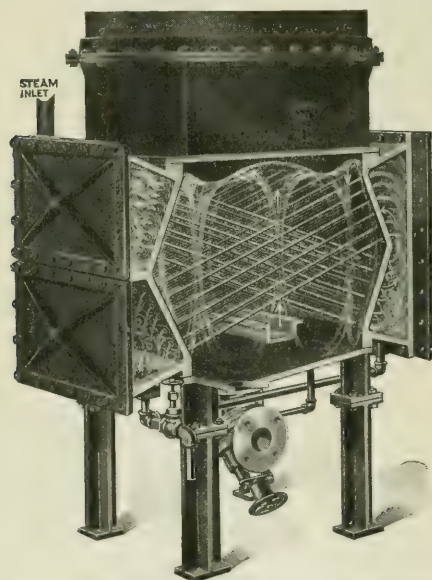


FIG. 1 Interior View of Criss-Cross Evaporator, Upper Portion of Evaporator Chamber Removed.

is passed in the evaporator, with the cooling water surrounding the tubes. The rapid condensation seems to pull the vapors in and no measurable back pressure was noticed. The circulation of vapor and liquid is very rapid and very satisfactory. It might sometimes be advisable to run the cooling water up inside the tubes and let the vapor being condensed surround the tubes. It could be introduced just below the cross as in the evaporator. With cooling water circulating inside the tubes there would be different temperatures at different points inside the vapor chamber, it being coldest at the point where the tubes cross. This would cause a rapid circulation of the vapor and a consequent high capacity.

The criss-cross principle is likewise applicable to steam boilers. They could be of either the fire-tube type with the hot gases inside the tubes and the water outside, or the water-tube type with the water inside the tube and the hot gases outside. In both cases the firebox could be put directly below the point where the

Modern Dyestuffs Industry

By Professor H. E. Fierz, Zurich

THE value of dyestuffs produced is very small compared to other world values, to wit, only £20,000,000, compared to £120,000,000 for cotton, £250,000,000 for wool, £500,000,000 for cereals, £250,000,000 for pig iron, and £60,000,000 for rubber, all these values being taken for the year 1913. In that year Germany controlled, taking all in all, at least 95 per cent. of this industry; but today, in many countries, enormous concerns have sprung up which ask for protection.

Before the war £10,000,000 was invested in the dye industry, producing about 200 per cent. of this capital in goods. This proportion has undergone a great change, and it is quite safe to say that now at least £40,000,000 is invested, which produces more than £20,000,000 of goods, or 50 per cent. of the capital, the demand being rather smaller than before. Profits which amounted to 16 per cent. on the average must have fallen to 4 per cent., because the general expenses are very much greater than in preceding years; in the United States, for instance, they are at least five times as large as in Switzerland.

Over-Production of Dyestuffs

The large indigo plants, alizarin works, and azo-color units have now been cut into comparatively small portions, and at the same time a very large over-production has set in. A strong factor of uncertainty and unrest has set in, and the hoped-for profits are not realized—a fact which is scarcely surprising if one considers that it very easily would be possible to manufacture all dyestuffs required for the whole world in a plant much smaller than Vicker's or Krupp's steel-works respectively.

The question put before us is: How can things be arranged without losing most of the capital invested in the world's dyestuff industry? Two problems have to be faced: (1) The actual dyestuff industry must be developed; and (2) the surplus of energy (capital and men) must be employed, or else they are lost for this end.

Let us consider dyestuffs as such, and later their possible outlets.

Essentials of Success in Dyestuffs Production

¹ The very first condition of any dyestuffs industry is excellent quality and absolute uniformity in standard strength, shade, etc. Before the war even minute deviations in any delivery caused serious trouble. In future the same quality will be necessary for any dyestuffs industry.

The second item is never relaxing progress. Any standstill means steady falling off, and leads to certain ruin, no matter how strong capital and determination may be at the beginning. This elimination has been witnessed forty years ago, and history, ever repeating itself, will do so if the same mistakes are made. The test of efficiency is the free export to the Far East. China and Russia, both as large as Europe, will absorb 50—60 per cent. of all dyestuffs produced.

Future Possibilities

The progress possible in the field of artificial coloring

matters, although more restricted than twenty-five years ago, is still enormous. Many of the existing products have become standard dyes. Alizarine indigo, indanthrene, chrysophenine, chrome-blacks, etc., are excellent; but we have no guarantee that any of these compounds will survive a serious attack of a new and better product.

Indigo has to fight strongly against hydron blue, fast blues, and sulphur dyes. Alizarine cannot extend its field because powerful competitors are appearing, and the tendency to employ better, although more expensive, dyes—a tendency originating in England—may kill many of the old friends, such as magenta, Bismarck brown, Congo red, and others.

One of the most important tasks of any dyestuffs manufacturer is to produce goods of as high purity as possible. It has been found that pure intermediates often give rise to much better yields and to better shades, which are sometimes surprising. At the same time, the fastness towards light, and sometimes towards potting and milling, increases very much. Azo-dyes, which are used for printing inks, often show great differences when freed completely from all impurities. Traces of naphthols and decomposition products, although quite colorless, might render such azo-compounds quite unsuitable.

In other cases, different salts show unexpected qualities. Columbia-black FF (a complicated trisazo-dye-stuff) gives a calcium-barium-salt which is so fast towards light that it has been proposed instead of carbon black, it being at the same time bleachable, so that waste paper could be easily recovered. In other cases, the isolation of a pure compound has led to the discovery of a new class of anthraquinone dyes. Alizarine saphirole is a constituent of anthracene-blue and the mother-substance of R. E. Schmidt's wonderful series of acid anthracene dyes.

Development of New Processes

The tendency to obtain purer and cheaper products gave rise to a large number of new processes. There are five different ways of preparing H-acid, three of preparing chromotropic-acid, three of obtaining gamma-acid, etc., etc. The very pure intermediate products enabled the research chemist to try new combinations—combinations which cannot be made with impure starting materials.

It has been said that the task of a chemist in a dye-works and similar undertakings resembles the task of a man who has to find a pin in a haystack. I beg to differ in this respect. A man who tries to find the pin will certainly find it if he is careful, but the chemist who tries to find without a strong chemical instinct, a kind of chemical genius, will not find anything. The great question is not to find the pin; it is much more important to know: Is there any pin in the great chemical haystack?

The possibility of finding new and valuable dyes depends not only upon careful research, but at least as much upon a traditional feeling and upon chemical inspiration.

Alizarine Substitutes

The efforts to improve a number of good dyes are so numerous that only a few can be mentioned. Take "Red" first. Alizarine is the best color in existence,

¹ Presented at the Edinburgh Meeting, September 9, before the Chemistry Section of the British Association for the Advancement of Science

but difficult to dye. Thus Congo red has partly replaced this substance, although it is extremely bad, except its beautiful shade. In recent years this benzidine color has gradually been driven from the market and replaced by better dyes. Its competitors are mostly derivatives of the aminonaphthol-mono-sulphonic acid 2.5.7 (J-acid), and it is surprising how many combinations have been discovered.

J-acid has been transformed into urea, thiazoles, benzoyl derivatives, azimides, and benzylidene compounds. These derivatives are transformed into azo compounds, which are on the market, under many names, such as rosanthrene, benzo fast red, Zambesi red, diazo fast red, etc.; and it remains to be seen which of the hundreds of combinations will remain victorious on the field. At the same time, even better-armed competitors have come. The old para-red, which has a poor shade, but which is very fast, is being gradually replaced by Naphthol AS and AN; and the preparation of the anilide of 2.3-oxy-naphthoic acid has already given rise to quite a number of new methods of manufacture.

Indigo Competitors

The fight between alizarine and its competitors is repeated between indigo and the newcomers. Indigo is no longer the absolute king, but is being pushed back slowly and steadily. Again, J-acid lends itself to the production of very fast blue and violet poly-azo dyes. The old and poor benzidine and dianisidine dyes are being replaced by these very fast colors, which, on cotton, are better than even indigo. Hydron blue, indanthrene, anthracene blue, and alizarine saphirole are competitors of great importance, and recently the complex chromium and copper salts of di-hydroxy-azo dyes have been threatening indigo as a wool dye. Indigo is still the dyestuff produced in the largest amount, China alone absorbing about £2,000,000 worth per annum, but it seems safe to predict that it has passed its zenith and will remain stationary, like alizarine. The discovery of artificial indigo has given rise to new and quite unexpected intermediates. Substances such as chloranil and diketo-dihydro-thionaphthene-dimethylamino-anilide are being proposed as new intermediates, and the anilide of arylamino-naphthoquinone is condensed with oxythionaphthene, giving rise to vat dyes similar to Friedlander's thioindigo. Even much more complicated substances are, however, appearing.

Vat Dyes

Vat dyes in general have undergone such a change as would have been believed impossible twenty years ago. Anthraquinone seems inexhaustible in this respect, although many of the new dyes are not so excellent as at first were expected. Not only alizarine and indigo are threatened; practically every coloring matter is open to attack. There is a perpetual fight, and no end to be seen. Changes are slower than before, but steady and unavoidable.

Suppose that every dye factory had its Sandmeyer or Perkin; suppose that every such factory had its new pyrazalone, tetrahydronaphthylamine, or diamino-benzophenone; what would be the consequence? The consequence would be that the slow change as just indicated would be accelerated, and in fifty years the very complicated compounds would be quite common.

This fine progress, however, would not eliminate the fact that today we have an over-production of at least 200 per cent. This over-production, although very strongly accentuated today, has been felt long ago. Many products of excellent quality could be sold only

with actual loss and with great difficulty. Therefore it is not surprising that for many years past the activities of dye factories underwent a steady modification because they tried to find new fields of activity.

Allied Chemicals

Several branches of technology have helped to put dyestuffs chemistry on a broader basis. These are pharmaceutical chemistry, photographic chemistry, tanning chemistry and technical colloids, such as celluloid, acetylcellulose, artificial leather, artificial horn, Bakelite, and, lastly, heavy chemicals, nitric acid, sulphuric acid, acetic acid, ammonia, etc. The large Continental firms have all, without any exception, directly or indirectly taken this course of development.

Pharmaceutical chemistry was first successfully attacked. Many of the intermediates of dye readily can be transformed into valuable pharmaceuticals. Phenacetine, antipyrine, salvarsan, etc., would be impossible had not the experience gained on the dyestuff field helped the research chemist; but here, also, the old substances are being gradually replaced. Antipyrine is replaced by pyramidone, veronal by dial and adalin, and digalene by new preparations.

Relations between dyestuffs and drugs are much closer, for not only are intermediates useful pharmaceuticals, but very often dyes themselves can be used advantageously. It is quite thirty-five years ago that crystal violet was recommended, under the name of pyoctannin, as a powerful disinfectant, but without great success. New compounds have since been discovered. It was found that the silver salts of many acridine dyes are very powerful disinfectants, being at the same time practically non-poisonous.

These dyes are used as a rule on leather with titanium-mordant, and this new discovery may lead to the replacement of the poisonous phenol and cresol preparations, some of which are, nevertheless, first-class pharmaceuticals. Certain aminobenzoyl derivatives of H-acid and similar amino-oxy-naphthalene derivatives are not only valuable intermediates, but also very potent poisons for blood parasites, and it may be that they would replace salvarsan! Pyrazolones are today equally important for antipyretics and new colors of the tartrazine series.

Photographic and Tanning Chemicals

Very similar relations exist between dyes and photography. P-aminophenol is important for the production of sulphur dyes and good photographic developers. Progress in dyestuffs has revolutionized the production of many photographic chemicals. The large production of plates and films was brought to perfection, especially in the great dyeworks on the Continent. The manufacture of acetylcellulose is dependent upon the large quantities of chlorine which are obtained by the electrolysis of sodium and potassium chlorides. Acetyl chloride is made by the interaction of sulphur chloride, chlorosulphonic acids, and sodium acetate. Camphor is partly replaced by acetyl-arylamines. Acetylcellulose is certainly a very interesting substance with regard to cinemas, but has scarcely great importance as a competitor of viscose.

Even by including pharmaceuticals and photographic chemicals, celluloid, etc., within its scope, the large dyestuff factory had not enough to do, and had still to find new and profitable fields of activity. The tanning industry offered a new outlet, since it was found that naphthols and phenols, by the action of formaldehyde

and sulphuric acid, could be transformed into valuable tanning substances which are actually used in large quantities. Bakelite and artificial substitutes for shellac are new and important substances, and the chief problem associated with this manufacture is the production of formaldehyde from coal.

This expansion of activities by the dyestuffs manufacturer is perhaps the most remarkable phenomenon in the whole field of technology. It is safe to say that the value of non-dyestuffs in these works is much greater than that of the dyestuffs themselves already, and will still increase. Heavy chemicals, such as ammonia and nitric acid, chlorine and caustic alkali, and even sodium cyanide, are, taken together, much more important in money value than the dyestuffs used in the world.

This rearrangement has necessitated certain amalgamations, which render Continental dye concerns very strong not on account of their capital, which is actually small, but on account of their co-operation and their great experience. This co-operation is possible because

the men who are directing business have all grown up with their plant, and are scarcely influenced by financial promoters from the outside. These amalgamations have not created any boom on the stock exchange; no shares were cut in tenths and pushed up to 100 per cent. again.

Dyestuffs chemistry is no concern of the financiers, but serious year-to-year hard work. It is, of course, easy to manufacture any product on a large scale; but the question is not to manufacture, but to sell. I have seen plants which could easily provide the whole world with H-acid, naphthol, or aniline; they are shut, because nobody wants such things. Steady and serious development is the fundamental condition of every sound dyestuffs industry; disappointments are more frequent than agreeable surprises. I have called my paper "Modern Dyestuffs Industry," but it actually no longer exists in the old sense. It has undergone a change into a much more important new industry, which might be called the new organic technical industry.

American Essential Oils

By G. A. Russell

Expert in Office of Drug, Poisonous and Oil Plant Investigations, Bureau of Plant Industry, Dept. of Agriculture.

FROM remotest times the various peoples of the world have used flavoring materials to improve or modify the taste of their foods and drinks. These flavoring materials have been derived mostly from plants which were used in the fresh condition, or, when desired for future consumption, were dried and stored. With increasing knowledge it was discovered that the flavoring constituents, such as essential oils, resins, gum-resins, etc., could be separated from the plants and thus be kept in more concentrated form; and with improvements in technology these have been obtained in a more and more pure condition until at the present time they are prepared in comparative excellence. However, much remains to be done in the way of methods, and a profitable field for research is here open to the investigator.

That the gustatory taste of the people of today does not differ materially from that of the people of antiquity is evidenced by the enormous trade that has developed in the production of flavoring extracts. Improvements in the old flavors, and production of new and delightful flavors have so broadened the field that it touches most of the things that one eats or drinks.

The whole world contributes to the raw materials which are employed in the manufacture of flavoring extracts, but to review them even briefly would require more space than is here available, and if published would make a book of considerable size. Likewise an exhaustive review of all the essential oils produced in the United States is beyond the scope of this article. Therefore I shall confine my remarks to such oils as are produced here and consumed in relatively large quantities, and to those which are extensively used but which are not produced here in any quantity yet which could possibly be produced at an economic advantage.

Growth of the Industry

In the census of 1914, 107 establishments reported as being producers of essential oils; in 1919 the number reporting had dropped to 78, but the selling value at the factory in that year for natural essential oils was approximately \$4,400,000, whereas in 1914 the value was

only slightly over \$1,250,000. These figures are by no means conclusive yet they indicate the growth of the business of producing essential oils, quantities of which find their way into the homes through the factories of the flavoring extract manufacturer.

Of the quantity of essential oils produced in the United States, as reported in 1919, approximately only 716,000 pounds, with a factory value of \$1,800,000, were obtained from domestic raw materials, the remainder coming from imported raw materials. From the domestic raw materials 716,212 pounds of oils were distilled, of which 697,086 pounds, or 96 per cent., may be classified as of interest to the flavoring extract manufacturer. This classification includes oils of peppermint, spearmint, black birch, wintergreen, sassafras, bitter almonds, apricot kernel, peach kernel, lemon, and orange. Peppermint oil occupies the most prominent place in the list from point of production, with orange oil ranking lowest.

Peppermint Oil

The production of peppermint oil in the United States can be placed in the class of minor agricultural industries, where it occupies a firm position. Its cultivation, no doubt begun on a small scale early in the history of this country, did not attain a commercial status until after the war of the Revolution. The cultivation of this mint appears to have been started in Connecticut, from whence it spread to Wayne County, New York, where in 1816 there was a considerable acreage planted, thence to northern Ohio and Indiana. In 1835 an industry of considerable magnitude was begun at Pigeon Prairie, Michigan.

Today we find peppermint cultivated as one of the regular crops in the muck soils of northern Indiana and southern Michigan, where the bulk of the American crop is produced. Wayne County in New York State still produces some mint oil which is rated the best of all American-produced peppermint. Within recent years the far northwestern states of Washington and Oregon have been producing peppermint oil and have so increased the number of growers and the acreage

cultivated that an association has been organized which, I am informed, will have committees to carry on investigations into the agriculture, technology, and marketing connected with the production of high-grade peppermint oil.

In view of the splendid results obtained in the cultivation of peppermint in the United States and of the widespread locations of suitable soils which could be utilized in its culture, it is somewhat surprising that in 1920 we imported 148,227 pounds of this oil. This quantity readily could be produced in our own country and the consumer would in general secure a better oil, for with small exception the bulk of the peppermint oil imported, when judged from the flavoring extract standpoint, is of inferior quality.

Spearmint Oil

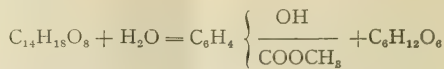
Spearmint oil came into vogue with the advent of a popular confection with which we are all familiar. The oil is produced from the plant known botanically as *Mentha viridis*, and in the same manner as peppermint oil, namely, by steam distillation. The area under cultivation in the United States is limited and approximates one-fifth of that planted to peppermint. The outlet for spearmint oil is restricted. It does not lend itself to diversified flavoring as readily as does peppermint and its use is therefore confined, at least at present, within certain limits.

Where one distilling outfit is employed to distill both peppermint and spearmint considerable difficulty is experienced in preventing contamination of one oil with the other. A trace of spearmint oil in peppermint oil will destroy the value of the latter. The converse, however, is not true. Spearmint herb ripens earlier in the season than peppermint and therefore is the first to be distilled. If the grower does not effectively clean his distilling apparatus, which requires time and money, his subsequent distillations of peppermint will yield a contaminated oil. Owing to these two difficulties,—restricted market and troublesome distillation—the small grower has been reluctant in attempting spearmint as a crop, with the result that its culture and distillation has fallen into the hands of large operators who have means and facilities for handling the crop on a large scale.

Black Birch Oil

The oils of black birch, wintergreen, and sassafras are obtained from trees and plants which are indigenous to the United States and which are found growing wild. Black birch oil is distilled from the bark of the tree *Betula lenta*; wintergreen from a small creeping plant, *Gaultheria procumbens*; and sassafras principally from the root bark of the sassafras tree, *Sassafras officinalis*. All these oils have been distilled in the United States for several generations past.

In distilling black birch two distinct methods are employed, depending upon the section of the country in which the oil is produced. In the New England and adjacent states the limbs of large trees and the entire young trees or sapling are cut into small pieces and distilled. The cut material is packed into a wooden vat fitted with a false bottom and a steam tight cover. A suitable connection is made between this vat and the condenser. After packing the vat full of the cut birchwood the distillate water from a previous distillation is added. This water is then heated by means of closed steam coils until the entire mass begins to steam. The heat is then cut off and the hot mass allowed to macerate for several hours. Maceration is necessary for production of oil since it is a product of the decomposition of the glucoside gaultherine.



Gaultherine + Water = Methylsalicylate + Grape Sugar

After sufficient time has elapsed heat is again admitted to the steam coils and distillation begun, which is carried on for several hours. The oil secured is separated from the water and filtered, and if darkened by contact with iron it is treated with tartaric acid which removes the color, and it is then ready for the market. The distillate water, which contains considerable oil in solution, is returned to a subsequent charge of cut birch wood.

The oil, which exists in the plant as gaultherine, is found only in the bark, hence by this method of distillation much inert material is handled in the wood. Economically, however, this method is the best known for to date no machine has been found that satisfactorily and cheaply will peel the bark from the uneven-sized saplings and brush. The spent wood is used for fuel under the boilers of the factory.

In the southern producing districts the bark is peeled from the trunk and larger branches by hand, shredded or cut by means of toothed rollers, then macerated and distilled. Young trunks and branches are sometimes used, especially the smaller ones from which it is difficult to peel the bark. The stills are often old copper whisky stills enclosed in brick work with the head projecting. A direct fire is used to heat the water in the still and the steam passing through the finely divided bark vaporizes the oil and carries it over into the condenser. Sometimes wooden vats or barrels, provided with perforated copper bottoms, are fitted over cast iron kettles which are filled with water for distillation. Direct fire is employed in heating the water and distillation is effected as described above.

The yield of black birch oil varies from 3 to 5 pounds per ton of raw material.

The federal government is frequently condemning parcels of adulterated birch and wintergreen oils. It is therefore to the consumers' advantage to deal only with reliable producers and brokers whose product can be guaranteed.

Oil of Wintergreen

The oil of wintergreen has been produced in the United States since 1863. The entire aerial part of the wintergreen plant provides the raw material. The method of obtaining this oil is practically the same as that used in distilling birch in the South, namely, maceration followed by the so-called water distillation. The yield of oil per ton of leaves averages approximately 12 pounds.

The true oil of wintergreen differs from the oil of black birch in being slightly optically active, it having an angle of rotation when freshly distilled of 0°.25' or longer—in a 100mm. tube. This property, however, disappears after the oil is distilled some time so that authentic chemical methods are lacking for distinguishing wintergreen oil from birch oil.

Synthetic methyl salicylate added to either of these oils can be detected, and this fact accounts for the seizures being made by officials enforcing the Pure Food and Drugs Act. Consumers of wintergreen and birch oils must rely upon the integrity of the producer and broker and upon their own trained olfactory and gustatory nerves to assure them that they are receiving what they purchase.

Oil of Sassafras

Sassafras oil, along with that of birch and winter-

green, was amongst the first oils to be distilled in this country. At one time a relatively large business was conducted in the manufacture and sale of sassafras, but with the finding of safrol in camphor this business gradually decreased until today only a few thousand pounds of the oil are produced. Nevertheless it occupies an important place in the trade, and apparently we can not well do without it.

Sassafras oil is distilled mainly in the states of Tennessee and Virginia, and in a more or less crude manner, especially by the small distiller. The stills are usually composed of a square tank built of wooden planks and fitted with steam tight doors for charging and unloading. The wood, which is split or sawed into small pieces, or the bark, which is often peeled off, is packed into the tank and distilled with steam over a long period, sometimes as long as 48 hours. The distillate of oil and water is usually condensed in a copper worm and after separating the water is allowed to run off. The spent wood is used for fuel.

The root bark yields from 5½ to 9 per cent. of oil, whereas the root wood yields less than 1 per cent. Artificial sassafras oil is merely a mixture of certain fractions of camphor oil and is difficult to detect when mixed with the true sassafras oil.

By-Product Essential Oils

The oils of bitter almond, apricot and peach kernels, as well as those of lemon and orange, are obtained in this country as so-called by-products. Essential oils from the former three are obtained from the press cake after the fixed oil has been removed, while the latter two oils are obtained from waste fruits.

The method of producing oils from almond, apricot and peach kernels is relatively simple. The oil does not exist in the kernels as such but results from hydrolysis of the glucoside amygdalin under the influence of the naturally existing ferment emulsin, or by boiling with dilute acids.



After the fixed oil has been removed from the kernels the latter are soaked in water for some time and then distilled with steam. Various modifications of technique are employed to prevent frothing due to large quantities of albuminoids present in the kernels. The hydrocyanic acid secured in the essential oil is usually almost or quite completely removed before the oil is marketed.

The processes as practiced abroad for securing oils of lemon and orange have been described in *CHEMICAL AGE*, Sept., 1920—"The Citric Acid Industry in the United States."

Lemon oil is being produced in California in considerable quantities and a very few hundred pounds of orange oil have been reported from the same State. Since both these oils enter very largely into flavoring extracts their domestic production should be encouraged in every possible way. Approximately \$1,000,000 worth of each oil was imported in 1920, hence a local industry of some magnitude appears possible.

In this connection some experimental work done in Florida on the production of sweet orange oil from cull oranges is of interest. In 1916 the Office of Drug, Poisonous, and Oil Plant Investigations, of the Bureau of Plant Industry, United States Department of Agriculture, demonstrated that a small profit could be made, under the circumstances existing then, by extracting the oil from cull oranges. A quantity of oil secured at

that time was sold to the dealers in essential oils and met with favorable comment.

Government Research in Essential Oils

In concluding this brief review of the production of American oils, I want to direct attention to some of the lines of work on essential oils in the office with which I am connected. Briefly, these are the fostering of production of American oils, the introduction under cultivation of new and promising oil-bearing plants, the conducting of researches into the composition of new as well as old and well-known oils whose composition is in doubt or which have been influenced by cultural or climatic factors, or both, and the improving of the technology of the production of these oils. These I think are purely governmental functions and represent broadly what we are trying to do in the field of essential oils. We appreciate suggestions and will welcome any from those in the industries affected by our work.

Virginia-Carolina Chemical Co.

Following Robert S. Bradley, chairman executive committee, American Agricultural Chemical Co., who reported in September *CHEMICAL AGE* a deficit of \$11,158,442 in his company's business for the fiscal year ending June 30, comes C. G. Wilson, president, Virginia-Carolina Chemical Co., who at the annual meeting of his company, on September 7, said that on a volume of business of \$87,058,974 for the year ending May 31, 1921, as against \$138,918,235 for the preceding year, the Virginia-Carolina Chemical Co. suffered a loss of \$15,634,356.

The fertilizer business has been the most seriously affected in the reactions of the past year. The volume of commercial fertilizers consumed for a given season is quite generally influenced by the trend of prices of farm products prevailing at the time the crops are planted.

Largely by reason of the expectation of reduced prices for farm products and to a considerable degree on account of the then high cost generally incident to farming operations, the amount of commercial fertilizer used during the fall of 1920 was but practically 80 per cent. of that of a normal season.

The cottonseed and edible oil industry experienced the most extraordinary year in its history. Crude cottonseed oil in May, 1920, was quoted at 16 cents per pound. In the course of the subsequent declines, the price in the spring of 1921 touched 3 cents a pound. As the movement of the market in all classes of edible oil products was steadily downwards from June, 1920, to April, 1921, this fact, coupled with the shrinkage in the value of the inventory on hand at the beginning of the new year, resulted in the reflection of a substantial loss in the operations of the Southern Cotton Oil Co.

Somewhat more than one-half of the total loss of \$15,634,356 as shown by the consolidated balance sheet of May 31 was sustained through the edible oil branch of the company's operations. The volume of business of the Southern Cotton Oil Co. was well maintained. Its foreign business, fairly satisfactory in volume, showed a profit.

Economies put into effect should show a substantial saving in operations. Factory wages have been reduced to the pre-war standard and the number of salaried employees with various constituent companies has been reduced. Salaries of executives have been cut.

Mr. Wilson believes that upon the whole the industries have entered upon a definite upward trend.

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A Consolidation of
The Chemical Engineer
and Chemical Age



RIGHT prices are those that will move goods; right wages are those that conduce to full employment. The controlling influence of the wage-cost ingredient of prices makes the latter of paramount importance in any consideration of ways and means to stimulate buying and to revive production.

Whether or not we consider labor as a commodity or as a relationship, its price in a free market is determined by the same law that makes the price of goods. The highest per capitum purchasing capacity in the world revolts at the conspiracy of organized labor to retain the war-time wage, because all other commodities are high, and to ignore the fact that commodities are high because wages are high—with the result that want stalks abroad in a land of plenty and idleness makes millions miserable.

WE have in this situation an example of the power for evil of a free-booting organization and of the supineness of politicians who share its responsibility.

Taxation that cripples enterprise; tariff agitation that instills uncertainty and only can result in increased distress of a world malady; transportation palsied by governmental interference with an agency that should be as free to respond to the restless energy of man as any other instrument of service; all these seemingly are ignored by President Harding's advisors on unemployment, who, in confession of human futility to preempt the province of economic law, advise production managers to split the job of the diligent with those who are laid-off first and ask municipal officers to accept as a community responsibility that which is a breakdown of national responsibility.

With hog on the hoof at 8 cents and pork chops 45 cents a pound, we have an epitome of the maladjustment of distributive processes to the prices of raw materials. Despite raw linseed oil in barrels at 75 cents and white lead at 13 cents (5 cents above pre-war price), the paint-maker's slogan, "Save the surface and you save all," is a mockery to the householder, with \$8-10 a day demanded by the simplest of the building crafts.

Emphasis of the elimination of waste in industry and of the introduction of increased efficiency in the work of production, as a present means of reducing costs and therefore the prices of goods, only tantalizes production managers who understand that these aspects of technology make up the narrative of industrial progress and are predicated on a volume of business that at present does not exist and presupposes a basis of profit unabsorbed by the tax collector.

Nevertheless, relegation to the people of the solution of problems for which in the final analysis they are responsible, should serve to bring home the principle of the citizen's trusteeship for his fellows only in the application of which can the great problems of the common weal be solved.

RECUPERATION from shock that shattered the economic structure of the world is a slow process that can be hastened only by a measure of cooperation that embraces the world.

The purchasing capacity of a large element of our people is determined by prices in the international market to which America supplies more raw material than any other nation. Our manufactured exports represent that quantity production which permits the *right price* and the *right wage* to American people and can be sold in the international market only as our production costs permit.

Our domestic troubles are but the local outbreak of a world disease with its seat in continental Europe. Until this spot is cleansed of the infection of political maladministration, and stricken peoples set aright, will we continue to have an ailing world.

Deliberately to restrict the power to pay for what is needed that all may prosper, to say the least, is not good merchandising which essentially is the highest type of philanthropy.

AS a further contribution of Government to the uncertainties of enterprise, and more particularly to weakening domestic chemical industry to meet foreign competition in the great variety of products in the manufacture of which alcohol is essential, is the proposal of the Senate Finance Committee to increase the tax on non-beverage alcohol from \$2.20 to \$6.40 per proof gallon (over \$12 per measured gallon) with a rebate of \$4.20 (\$7.60 per measured gallon) on proof that this indispensable chemical raw material has not been diverted to illegitimate use.

We have in this proposal that would require from the manufacturer a payment of \$600 on each barrel of alcohol removed from bond the most pernicious type of governmental oppression, in that a discredited arm of law enforcement joins with the tax collector to penalize industry by imposing a crushing financial burden, and to thrust upon the manufacturer the additional burden of proof of legitimate use.

Present procedure amply protects Government. To inflict upon industry, and through it to add to the burdens of consumers, the deficiencies of its agents, is a commentary on the economic aberration of politicians and reformers.

IN eutopies each era represents an improvement in human surroundings; in eutechnics man makes these conditions possible, for each era surpasses the former in progress in his occupations and activities; in eugenics serious questions are raised as to improvement in the human breed.

These questions are of direct moment to American chemists for as a social group they are not biologically self-sustaining, — an indictment embracing the larger group in which reposes the responsibility for the maintenance and advancement of the culture of the race.

However much we deplore an economic situation that may inhibit the natural instincts of chemists and of the larger group of which they are a part, we do not share with certain high-brows the gloomy forebodings for the future of the race because the progeny of the educated suffers numerically in comparison with the offspring of the lowly.

Nature in her inscrutable wisdom made vertical the cleavage in human capacity and aspirations. The woes of the world largely flow from man's selfish effort to con-tort the vertical to the horizontal in his desire to conserve to class and caste the advantages of accident and aim. Otherwise, where is the sanction for ambition?

With all the captiousness of critics Nature does things remarkably well. She does not intend that any class shall have other than a limited estate in any aspect of life, but that it may be enjoyed by all correspondingly to desire and capacity; and so Nature provides that the race shall die at the top and ever renew its virility at the bottom.

Unmindful of the philosophy of the Master who declared that he who would gain his life must lose it, eugenists emphasize unduly the natural phenomenon of a low and decreasing birth-rate among those who should bear the heaviest burdens of social responsibility.

That those who feed the race do not enjoy the cultural attainments inseparable from reduced fertility merely serves to emphasize our responsibilities to those less favored that the heritage of our institutions shall not be dissipated.

That the high-brow has not as many children as the section-hand is a God-send; that the cultured have not the fecundity of the ignorant is a wise provision of Nature; that special favor of any sort should become ossified in the social structure is repugnant to the thoughtful who realize that growth in all that that term implies can come only through exercise; for it would mean the horizontal cleavage of class and caste desired by man but abhorred by Nature.

A JOB PRINTER of Flint, Michigan, has an article in the October *Atlantic Monthly*, which we commend for the perusal of Herbert Hoover. Hoover tells us that the repetitive process of industry are dulling the human mind. We said two years ago that it is the ill use of the leisure with which inventive ingenuity has endowed labor that perverts and atrophies the human mind.

Thrift applies to leisure as truly as it does to money

and adds a new responsibility to education in a democracy.

WITH the admission of organic chemical manufacturers to membership in the American Dyes Institute there now exists in chemical industry two outstanding trade organizations, viz., the manufacturing Chemists' Association of the United States and the American Dyes Institute, emphasizing respectively heavy and fine chemical manufacture and reflecting the commercial interests engaged respectively in applied inorganic and organic chemistry.

Salesmen of chemicals have effected a national organization devoted to the study of problems of distribution.

Chemical machinery manufacturers organize to advance various interests which, they say, can be promoted more satisfactorily by action as a group rather than as individuals.

The philosophy of the American Institute of Chemistry has been expounded in these pages and has been received with commendation and hearty acceptance from every department of chemical industry, save the coterie that controls the management of the American Chemical Society and which, as a sop to the movement to effect an economic organization of chemically educated men devoted to the recognition of the professional status of chemists, proposes that the American Chemical Society shall relieve the Chemists' Club of the licensed employment agency run by a couple of girls, which, in consideration of a registration fee and a percentage of the salary, undertakes to find the applicant a job.

We are concerned here with a professional organization of chemists, run by chemists for chemists and not a scientific or educational institution run by chemical politicians for the perpetuation of control, with merely such concession to the demands of the time as will keep the machinery intact.

We want to emphasize the instability in this age of specialization of any organization that ignores the material bases that support economic relations and which is saturated with the idea of "one big union,"—an anachronism meeting ever with relegation to a past when one organ performed a multiplicity of functions.

At no time in the brief history of industrial chemistry as we know it today have the human problems of its educated workers demanded the study that they do today, and will continue increasingly to demand, that waste in their production may be minimized and that industry's progress may reflect the highest efficiency in their utilization.

For the "bosses" of an educational society to discourage among men who appreciate its great usefulness the formation of a distinctively economic organization having to do solely with the material problems of the practitioners of the profession of chemistry, is to do the science and art of chemistry a positive disservice, particularly in a time that calls for organization and is answered in every quarter not subject to baneful sinister influence.

Nitrogen Fixation and the German Disaster at Oppau

By Theodore W. Sill

Ex-Major, Chemical Warfare Service, U. S. A.

Member of Inter-Allied Commission to Inspect German Chemical Plants, February, 1919.

THE startling news of the frightful disaster September 20, at the Badische nitrogen fixation plant at Oppau, the announcement of Dr. Nichols of the successful progress of the work being conducted by the Allied Chemical & Dyestuff Co. at Syracuse in the production of synthetic ammonia for use in the Solvay process and the interest aroused by the possibility of Henry Ford entering the field of chemical manufacture by the purchase and operation of the Muscle Shoals plants, have focused attention on the vital and all-important question of the manufacture of ammonia, nitrates and allied products from the nitrogen of the air.

Few people, outside of ardent students of chemistry and those closely connected in a commercial way with nitrogen products, realize the great importance present and future of this situation and its effect on the entire world.

The American people, apathetic as they are to the rapidly decreasing supplies of such natural resources as coal, oil, gasoline, timber, tanning materials, varnishes, gums, etc., characteristically fail to realize the accelerated diminution of nitrates which we have hitherto without any worry depended upon from Chile year in and year out.

But the end of this natural supply can be reckoned and so in recent years synthetic methods of preparation of ammonia and nitrates have had the attention of chemists throughout the world. The electric arc process, employing Schönherr, Birkeland, Eyde or Pauling furnaces, the cyanamid process, the Serpek process employing alumina instead of lime, and the Bucher process of developing sodium cyanide from soda ash, have all been worked more or less successfully, particularly the cyanamid process, helping materially to increase the synthetic supplies of nitrogen products.

But it remained for Germany, her supply of Chilean nitrate cut off by the blockade, to develop the best of the synthetic processes, *viz.*, the Haber system. Goaded to desperation by the urgent necessity of obtaining supplies to meet her intensive war program and backed by the power and finance of the German government, the Badische Co., starting with a small partially worked-out process at its Oppau works, with characteristic German chemical ability and patient mastery of details, accomplished the remarkable feat of perfecting this process so that production of about 25 metric tons of ammonia per day at Oppau was increased to about 250 tons per day and at Merseburg (in Halle' near the Strassfurt salt deposits) was erected and put into operation a plant which produced about 400 tons of ammonia per day at the close of the war. This extraordinary development well may be regarded as the greatest feat of chemical engineering in the world today and fills anyone with awe who may behold it.

The development of the Haber process without any

doubt, in supplying the great demand for explosives for the battlefield and fertilizers for the field, saved Germany from an early surrender in 1916. Co-ordinating with the Ostwald process for oxidation of ammonia, produced by the Haber process, into nitric acid, Ger-

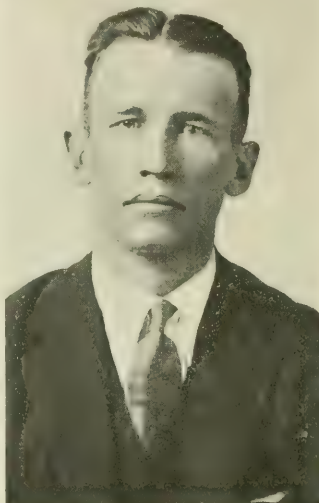
many has about fourteen large plants, many of them erected during the war, which can fix nitrogen up to about 500,000 tons per year, thus making her not only independent of the rest of the world, but also with an excess of nitrogen products which could be sold cheaply in other countries unless sufficient tariff protection be effected. Previous to the world war the Germans imported some 750,000 tons of Chilean nitrate per annum representing 115,000 tons of the essential nitrogen. During the war Germany used approximately 200,000 tons of nitric acid per year in explosives. When it is realized that Germany increased her production of essential nitrogen to about 500,000 tons per year and her ammonium sulphate supply from 30,000 to 300,000 tons per year, the magnitude of these operations better can be appreciated.

The writer had the exceptional opportunity of visiting Oppau as well as the majority of German chemical plants shortly after the armistice in the early winter of 1919, as a member of an inter-allied commission to inspect the war activities of these plants. One who has observed the marvellous and awe-inspiring evidence of the working-out on a great practical basis of such a remarkable human accomplishment as the Haber process, cannot but deplore this destruction and apparently great loss of life, as the reports indicate, regardless of what may have been the principles and unsavory record of the German nation in the past.

Interessen Gemeinschaft

While giving thought to Oppau itself it is of interest to consider its relationship with the German chemical industry in general, it being but a link in the great chain of the *Interessen Gemeinschaft* (I. G.).

This I. G., a chemical trust far greater than any combination dreamed of in this country, represents the union of two powerful groups consisting on the one hand of the Bayer plant, the most modern and extensively developed plant located at Leverkusen near Cologne and Elberfeld; the Badische Co. at Ludwigshafen, including Oppau, on the Rhein opposite Mannheim and incidentally the largest chemical plant in the world; and the *Aktien Gesellschaft für Anilinfabrikation* at Berlin—and on the other hand the great Meister Lucius and Bruning at Höchst near Frankfurt, where we read of great labor disturbances at the present time; the Cassella Co. at Mainkur near Frankfurt; the Kalle Co. at Biebrich near Mayence; both of which groups have now united with a combination of the Griesheim Co., located near Frank-



THEODORE W. SILL
Ex-Major, Chemical Warfare Service,
U. S. A.

fort and famed for its electrolytic developments, the Weiler-ter-Meer Co., located near Dusseldorf, below Cologne on the Rhein, and Leonhardt & Co., at Mulheim, near Frankfurt.

A study of the map will demonstrate the geographical contiguity of these plants, practically all of them being located along the Rhein, the exception being the *A. G.*

development and stability of our own chemical industry.

As an illustration of the German war-time expansion the following reported figures are of value:

Metric Tons of Ammonia Per Day

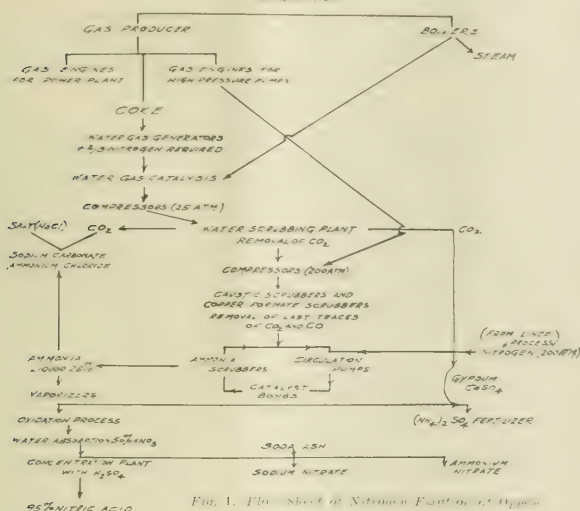
	1914	1918
Oppau	25	250
Werseburg	0	400
Total	25	650

Metric tons of Nitric acid (100%) per Day.

	1914	1918
Leverkusen.....	56	180
Hochst.....	150	375
Oppau.....	Not reported	100
Ludwigshafen.....	40	40
Weiler-ter-Moor.....	12	24
Total.....	258	719

The Badische Company's plant is divided into two parts. One the original Anilin and Soda Fabrik, and the other the Fabrik Oppau where air nitrates and allied products are made. The total area occupied by the two plants is about 235 hectares. The Ludwigshafen plant employs about 11,500 men and the Oppau plant about 3,500 men and some 250 chemists, half of them occupied in research work and half in control. The buildings at Ludwigshafen were laid out in more or less rectilinear lines and were built of brick about two stories high and rather old and dingy in appearance in contrast to the clean, attractive type of buildings at Oppau where both concrete and brick were used with a lot of steel girders. The Oppau plant is located on the Rhine River bank about one mile and a half from Ludwigshafen, being connected by the commutative trolley line. The lay-out of the works is well shown in the accompanying sketch, 3, an interesting right-angle roadways about 100 feet wide. It was built on a permanent basis costing in the neighborhood of \$75,000,000, so some idea of the magnitude of the loss in this disaster may be obtained from the newspaper reports are correct.

The offices and laboratories were extensively and elaborately decorated, while the power house producing some 16,000 E.H.P. and the various compressor houses

Fig. 1. Plot sheet of Neutron Flux at $\theta_1 = 0^\circ$ to 90° .

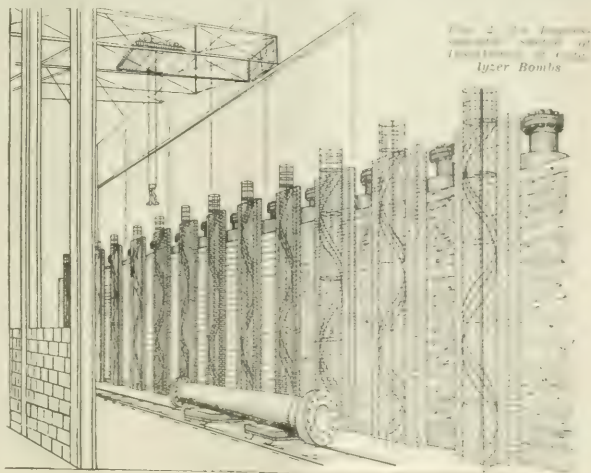
F. A. of Berlin. Also one may note the proximity of many of the important ones to Frankfort, a district the French have so often threatened to seize if Germany tried to evade the treaty terms. Most of these plants are now in the zones occupied by the Allied armies. The Belgians watch over Wieler-ter-Meer; the British over the Bayer plants; while the French exercise a strict control over the Meister Lucius and Bruning, the Kalle and Badische plants and possibly some others now; while the American army guards the beautiful scenery of the Rhein.

The favorable location along the Rhein and the well-worked out plans of cooperative manufacture as well as selling make this combination particularly strong and effective in peace as in war. We will give them their practical domination of the chemical industry and the thousands of allied industries using chemical products, unless the proper protection is allowed by Congress to enable our own chemical industries to grow and get on their own feet.

German Chemical Arsenals

The majority of the German plants produce dyestuffs and pharmaceutical products in peace time, but are suitable as they exist for producing large supplies of new poison gases and explosives and to facilitate large scale production as well.

It is almost inconceivable to anyone making a superficial examination of the fact that some of our most experienced and thoughtful statesmen fail to appreciate the great military value of such types of plants as these and their great peace value in the production of dyes, drugs and fertilizers and continue to block legislation to foster the



lyzer Bombs

and control stations were most substantially constructed.

The total Oppau output of 250 tons of ammonia per day, equivalent to about 80,000 tons annually, was distributed as follows:

	Tons per diem	Tons per annum	Tons NH ₃ Equivalent
Ammonium Nitrate.....	26	9,500	4,750
Sodium Nitrate.....	340	120,000	30,000
Nitric Acid.....	100	35,000	12,000
Ammonia Liquor sent to Höchst, etc., for oxidation			30,000

It is not our purpose here to enter into a technical discussion of the Haber process, but the accompanying flow sheet (Fig. 1) will give a general idea of the plan. The nitrogen obtained from liquified air is mixed in the steel catalyst bomb with hydrogen, thoroughly scrubbed after production from lignite-water gas, in the presence of the iron catalyzer. After purification the ammonia thus produced is then oxidized to nitric acid or carried on into other products.

The most important elements of the operation are the catalyst bombs and the catalyst itself. These "bombs" are of special Krupp steel forgings built to stand enormous pressure under high temperatures. An impressionistic sketch of the setting of these bombs is shown herewith (Fig. 2). There were about fifteen of these

bombs having an estimated capacity of about 20 tons of ammonia per day. The catalyst bombs were a source of great and constant danger; a serious blow-up occurred in September, 1917.

The cause of the present great disaster is naturally largely speculative, so confusing are the various newspaper reports, but it is reasonable to surmise that a repetition of the previous explosions but on a much larger scale well may have been a contributory factor to a disaster of such magnitude. It may be probably that there were also explosions of some large amounts of stored nitrate materials.

The results of such a great disaster are, of course, problematical. Aside from affecting the morale of the workers and those directly connected with the company, it is bound to cripple the activities of the associated companies for some time. It may be assumed that they will rebuild in time, meantime the assistance of the other plants, such as Merseburg, may be called for and the production of German chemicals, dyestuffs, etc., should be only temporarily halted. Doubtless, the construction of a new plant would be advantaged by the experience acquired in the former which might be said to have been partially in the experimental stage and constantly was being improved.

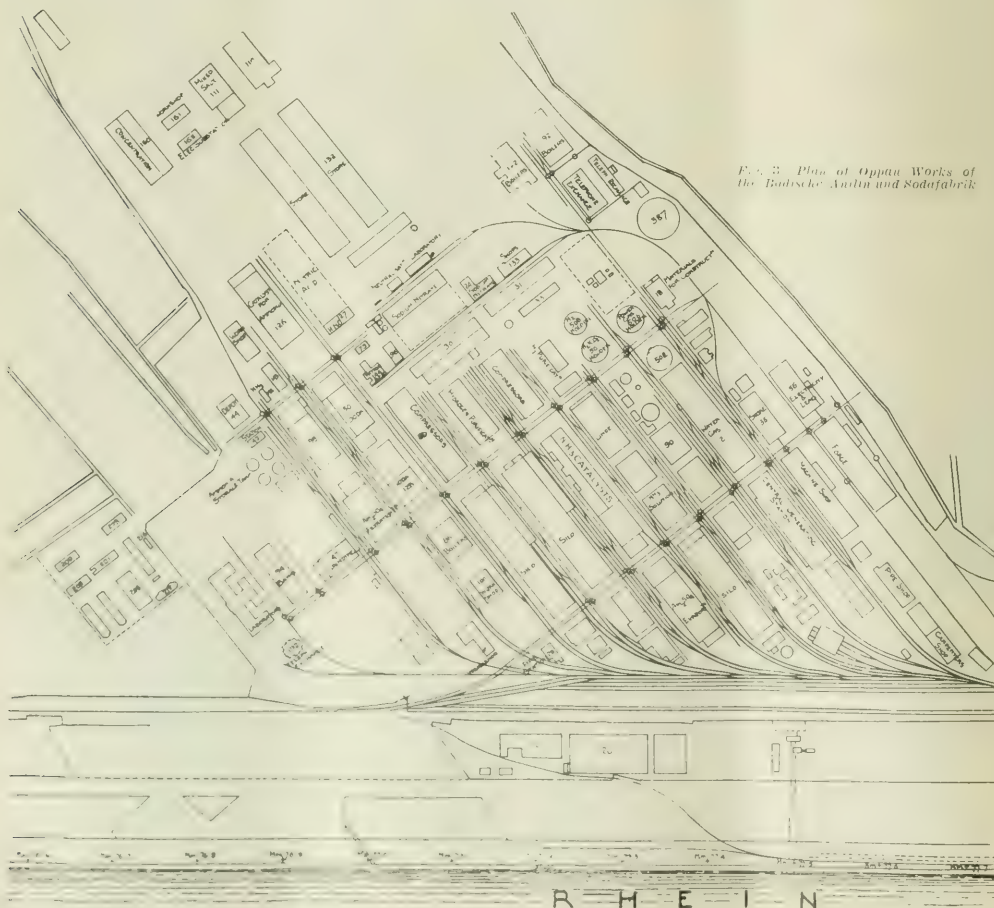


Fig. 3. Plan of Oppau Works of the Badische Anilin und Sodafabrik

Crude Rubber Surplus and Control of Production

In crude rubber is found one of the anomalies of war conditions, in that the industry is practically the only one that did not share in the general price advance that set in almost immediately after the armistice. On the contrary, while the price of everything else was mounting to unheard-of heights, crude rubber prices steadily declined from the Government-fixed maximum of 62-63 cents a pound, to the lowest notch in its history of 11½ cents, which was reached last June.*

Crude Rubber Prices and Imports

Manufacturers of rubber goods had their "day in court" along with the manufacturers of other things. They had every opportunity to take advantage of the "boom" condition that existed for two years or more and place their business on a footing to withstand the crash that everybody knew was sure to come "some day." Not so with the producers of rubber, although they did have their innings ten years ago.

The end of the inflation period, which came in the summer of 1920, found rubber prices already deflated to a point approximately 25 cents below the Government war maximum, and a full year of deflation now finds standard grades of rubber selling at about 14 cents a pound, a recovery of less than 3 cents from the abysmal depths of last June. Add to this the huge stocks of rubber held in this country, in England and in the East, and a lack of demand that has diminished United States imports of plantation rubber from 134,403 tons for the first six months of 1920 to 71,322 tons during the corresponding period of 1921, and it will easily be seen that eastern planters have cause for worry.

Rubber Plantation Investment

The crude rubber industry is essentially British. Englishmen conceived the idea of growing Para rubber in the alien soil of tropical Asia. British investors in the numberless joint stock companies control fully 80 per cent. of the plantation rubber business. Netherlands interests control approximately 10 per cent., and another 7 per cent. is owned by scattering Chinese and native Malay and other interests.

America's interest in plantation rubber is but about 3 per cent. of the total investment in that industry. It must be remembered, also, that this 3 per cent. is practically all in the hands of two of the largest rubber manufacturers of this country, the United States Rubber Company and the Goodyear Tire & Rubber Company, whose plantation product is entirely consumed in their own factories.

The United States, however, uses practically 70 per cent. of all the rubber produced. It cannot be said, therefore, that America's interest in the efforts of the British and other plantation owners to remedy the unfortunate position into which their industry has been plunged is entirely academic or merely sympathetic.

Over-Production

Contrary to the belief often expressed in British rubber circles, but more vociferously insisted upon in the East, American rubber manufacturers and importers do not consider the present depressed price of rubber to be an advantage to themselves or to the best interests of the trade. They realize that, at present prices, rubber is being sold below the cost of production—an uneconomic condition that can make for no permanent advantage to anyone.

The seat of the trouble is, of course, over-production, caused largely by an over-optimistic estimate of United States demand on the part of the plantation owners. Over-production began to develop as far back as 1918. Automobiles consume annually about 70 per cent. of all the rubber produced. Plantation rubber owners saw the production of automobiles in the United States increasing by leaps and bounds. They thought there was going to be no break in this phenomenally increasing demand and they rose to meet it. Up to 1917 automobile production had suffered no set-back. In that year 1,868,949 new cars were manufactured. In 1918 the production fell to 1,153,638 cars, a drop of 38 per cent., while crude rubber production increased from 265,698 tons in 1917 to 296,597 tons in 1918; an advance of about 12 per cent. Add to this the fact that the Government of this country sharply restricted imports for a considerable period during 1918 in order to conserve steamship space, and the real surplus began to develop, which since has been constantly increasing.

That the danger of a rubber surplus was by no means unanticipated in British circles, is evidenced by the prediction of J. S. N. Rennie, who clearly saw production advancing more rapidly than demand. He was quoted in the *Times Trade Supplement*, London, in 1917, as warning rubber growers that unless they were more careful with their production in the future than they had been in the past, in less than ten years' time "the selling price must logically fall to the approximate cost of production." What Mr. Rennie saw as an eventuality in ten years' time became an actuality in less than four years.

One of the principal difficulties in solving the problem of the rubber surplus is that nobody knows with any degree of accuracy the exact amount. In spite of all manner of restriction and curtailment schemes, the surplus seems to be accumulating rather than diminishing. As quoted in *London Financial Times* last November, upon estimates made by Richard H. Tingley, the world's surplus stocks at that time amounted to about 200,000 tons, held about one-half in the United States and one-half elsewhere. It is now estimated by American authorities that stocks amount to nearer 250,000 tons, of which 70,000 to 80,000 tons are in this country, 75,000 tons in Great Britain, and 100,000 tons in the East or afloat, while the Rubber Growers' Association of London places the world stock at 300,000 tons. These figures, however, are little more than guesses.

Curtailment of Plantation Output

Ever since last fall efforts have been made to curtail plantation rubber output. A 25 per cent. voluntary reduction was first tried, but, like many similar endeavors in other industries, the experiment failed. Each planter sought to obtain advantage over his neighbor, and by the early part of this year it had been well demonstrated that the effort would amount to nothing. Eastern planters apparently could not disabuse their minds of the thought that America was bound to "come back," and soon.

The Malay Peninsula produces more than a half of all the crude rubber grown. The Planters' Association of Malaya, which is composed of the managers and planters of the rubber estates of the Federated Malay States and the Straits Settlements, realizing the failure of the voluntary restriction program, presented the Government of the Federated Malay States with an

*The Chronicle, New York, September 24, 1921.

alternative plan, of which the following is an outline:

A 50 per cent. compulsory reduction in the output of all rubber estates in the Federated Malay States and the Straits Settlements on the actual crop of 1920.

Estates unable to conduct business owing to lack of funds might apply to and receive Government assistance up to a maximum of \$3 (Straits) per acre per month.

The Malayan Government approved these proposals, but before legislation of the kind could be passed, authority from the Secretary of State for the Colonies at London was required. The proposal was therefore cabled to him. The Secretary, in turn, consulted the Rubber Growers' Association of London, which represents all the big rubber companies whose registered offices are in London.

Precisely what happened has never been made clear, but the outcome was that the Rubber Growers' Association declined to agree to any plan of compulsory restriction. All of this occurred last winter, and it seemed apparent to the Planters' Association of Malay and to the Malayan Government that no compulsory scheme for curtailment could be carried out. It also seemed apparent that the London association was perfectly willing to allow the weaker and badly financed estates to pass out of existence.

English Action

It is more than probable that, in turning down the compulsory plan proposed by the Malayan association, the London association had the larger and more comprehensive scheme in view which, it hoped, would accomplish the same objects—and more. This plan has now found expression in an elaborate proposal by the London Growers' Association, under which it hopes not only to control the rubber output, but rubber prices as well, to the advancement of its members' interests.

The details of this plan were submitted to the association at a meeting held in London on July 16 by Chairman Sir Stanley Bois, and contemplates the formation of a company composed of members of that association, with a capital of £2,000,000 and a borrowing capacity of £8,000,000.

In putting the plan forward Sir Stanley states the governing factors as follows: (1) That the existing world's stock of rubber is 300,000 tons; (2) that the potential output for 1922 is over 400,000 tons; (3) that the potential consumption for 1922 is not likely to exceed 250,000 tons. It was further brought out that, unless two-thirds of the planted rubber area came under the proposed control by becoming members of the new company it would not be brought into existence, and furthermore, that the success of the movement would depend in a large measure upon similar action being taken by Dutch interests, which do not appear very enthusiastic on the subject.

Many of the objections raised to the above plan are well taken, and the fact is disclosed that there is by no means a unanimity of opinion among rubber men in England of the advisability of the control scheme.

American Opinion

Many American manufacturers are inclined to look askance at the plan. They all will welcome any scheme that tends to reduce rubber stocks and restore normalcy to prices, but they see that, possibly, only two-thirds of the rubber producing area may be brought under the control, and, while this is being done, the other third will have a protecting umbrella held over their heads while they do as they please. In this outside third are to be found the Chinese, Malayan and other scattered ownership that would not be slow to take advantage of the protection thus offered.

Old-time rubber men recall the disastrous results that attended the efforts on the part of the Brazilian Government to control output and prices twenty or thirty years ago; also, similar attempts by private parties to work out control and regulation of the Brazilian market for both rubber and coffee which occurred some years afterward and which failed signally, costing those responsible for the movement a large sum of money.

American economists who have studied the British control plan see in it an element of an artificial manipulation that seeks to set at naught the immutable law of supply and demand. As now being conducted the plantation rubber industry seems capable of taking care of itself in time, if left to itself and to natural laws, notwithstanding the fact of the recently increased surplus. It has taken Eastern growers a long time to fully make up their minds that the hitherto gargantuan appetite for rubber in the United States no longer exists, but they have finally come to it.

Reports are daily and weekly coming in telling of the failure of this or that company, or of the voluntary abandonment of this or that plantation, one of the latest being that 115 estates owned by large companies had curtailed production 60 per cent. in August. In the aggregate the effect of this must soon be reflected in production totals, for no industry can long endure which must sell its product below the cost of production. Weak sisters are, and will be continually, falling by the wayside. Their properties will, in the course of time, be taken over by stronger interests. It is a case of the survival of the fittest.

America, always optimistic, is disposed to take a cheerful view of the rubber situation—be the surplus 250,000 tons or 300,000 tons. It is pointed out that these figures are not all surplus stocks, and that at least half of the amount represents necessary stocks that good business prudence requires always to be on hand in order to fulfill trade requirements.

Nobody knows the exact extent of the curtailment process now going on in the East. It is known, however, that a large and constantly increasing number of estates are abandoning production—some wholly, some in part only. Private unpublished advices recently received from Singapore from parties who have just completed an exhaustive survey of the entire Eastern situation state (as of June, 1921): "Failing some change in the position, either by increase in the price or some general and effective restriction scheme, I do not think that the output for 1921 will exceed approximately 65 per cent. of the figure for 1920."

Henry C. Morris, M. I. T., '01, has been appointed head of the new Fuel Division, Bureau of Foreign and Domestic Commerce. Mr. Morris entered the Fuel Administration in 1917 as a mining engineer, serving until May, 1918, when he was transferred to the Bureau of Mines, where work included membership on the Capital Issues Advisory Committee and related applications and on the War Minerals Investigation.

Later he served as representative of the Bureau of Mines on the Economic Liaison Committee at its inception and served until resignation in June, 1920.

Later he collaborated with four others in preparation of report for the United States Shipping Board on fuel-oil supply. He was contact man in international petroleum matters with the State, Commerce, and other departments, and made a special study of the whole subject for the Director of the Bureau of Mines. Recently he prepared a booklet on the raw material situation in the United States for the U. S. Chamber of Commerce.

Present Status of the Domestic Coal-Tar Products Industry

By C. R. DeLong

Chief Chemist, United States Tariff Commission.

WITHOUT repetition of the statistical matter in the 1920 report of the Tariff Commission, which the trade has had two months to study, there are salient points in the development of the American coal-tar products industry since the Commission took its first census of dyes and coal-tar chemicals in 1917, that can be reviewed with a measure of interest.*

Progress of the Industry Since 1917

During the period from 1917 to 1920, inclusive, the total production of finished coal-tar products increased from over 54,000,000 pounds, valued at \$69,000,000 to approximately 113,000,000 pounds, valued at nearly \$113,000,000. This represents approximately a doubling in the output during the last four years. During this period the output of dyes represented approximately 85 per cent. of the total quantity of finished products, and therefore may be regarded as the backbone of the coal-tar products industry. The output of dyes has followed the general trend of the industry as a whole and reached in 1920 somewhat over 88,000,000 pounds valued at \$95,000,000.

There have been many remarkable and striking increases in the output of individual dyes during this period. Indigo, the most important dye and one which involves rather complicated processes of manufacture, may be cited as an example. This dye increased from an output of 275,000 pounds in 1917 to more than 18,000,000 pounds in 1920, which quantity was approximately double the pre-war importation. The average price of indigo produced in 1917 was \$1.24 as against a price of 74 cents in 1920. The loss of the export market in indigo has resulted in keen competition between domestic manufacturers with a reduction in price to a minimum of around 40 cents a pound or nearly one-half the average price for 1920. Other examples of this kind might be cited.

Vat Dyes Other Than Indigo

The group of "vat dyes other than indigo," which are comparatively insignificant so far as quantity consumed is concerned—pre-war imports amounted to only about 4 per cent. of the total imports of dyes—has caused more discussion as to the sufficiency of the domestic industry than any other group of dyes. The output of this group has progressively increased from a little over 15,000 pounds in 1917 to 1,160,000 pounds in 1920, or 1.3 per cent. of the total domestic output. The increase in production of vat dyes, however, may be accounted for by a few dyes, especially Brom-indigoes, Indanthrene Blue, G.C.D., and Indanthrene Yellow. Therefore there still exists a certain lack of variety in this class.

The early development of this class of dyes was hampered by several factors, among which may be mentioned the scarcity and difficulty of obtaining an adequate supply of anthracene, German control of patents until October, 1917, the complicated chemical nature of the dyes which require complex manufacturing processes, and the relatively small consumption of this group of dyes. The progress during 1920 has demonstrated the ability of the American dye industry to produce this group of colors in commercial quantities. The raw material difficulties have been solved by an increased output of anthracene and the development on a commercial scale of synthetic anthraquinone.

There only remains the manufacturing difficulties to be solved by the domestic industry, which it may be predicted with reasonable certainty will be overcome in the not distant future. Much of the research necessary for the vat dyes has been completed, but the installment on a commercial scale has been delayed because it has been deemed not wise to invest the necessary capital—which is large in proportion to the value of the dyes in a period of uncertainty.

Miscellaneous Coal-Tar Products

The development and output of other finished products may be briefly noted. Coal-tar medicinals doubled their output to 5,000,000 pounds in 1920; perfume materials increased from 19,000 pounds to nearly 100,000 pounds in 1920; while the production of synthetic resins from coal-tar products reached a total of 4,500,000 pounds in 1920. Flavors is the only group of coal-tar products that has shown a marked decrease in this period when they declined from 780,000 pounds in 1917 to 167,000 pounds in 1920; this, however, may be largely accounted for by saccharine.

Another important development which took place largely during 1920 was the increase in the output of synthetic tanning materials, which reached over 3,000,000 pounds in 1920 by four firms. This is a marked increase over 1919, when there was only one manufacturer of this product. With our rapidly decreasing domestic supply of natural tanning extracts, the leather industry may be assured that a domestic supply of these essential raw materials will be available from the coal-tar products industry.

Camphor Substitute

Another example may be cited of the possibility of synthetic coal-tar products replacing those of natural origin. The high price of camphor during the war led to search for a substitute, with the result that triphenyl and tricesyl phosphates were introduced as substitutes for camphor in the manufacture of pyroxylin plastics. The fact that in the past Japan has enjoyed a complete monopoly of the world's supply of camphor is well



C. R. DE LONG
Chief Chemist, United States Tariff Commission

* Delivered at the New York meeting of the American Chemical Society, before the Division of the Commission, September 9, 1921.

known to all. It is extremely doubtful whether these two coal-tar products can replace camphor in pyroxylin plastics for all purposes. But these coal-tar products offer a means of overcoming to some degree the Japanese monopoly in camphor. From a national standpoint the development of these camphor substitutes cannot be overestimated.

With the knowledge of these recent developments in the application of coal-tar products before us we cannot help but wonder what the future holds in store for continued research.

Relation of Research to the Industry

I wish to emphasize the role which research has played in the development of the domestic coal-tar industry. Information compiled by the Commission shows that between 10 and 11 per cent. of all of the employees are chemists or technically trained men. This is undoubtedly a larger percentage than will be found in any other industry. Of course all of these chemists are not engaged in research work.

The total expenditures for research work in the industry, from 1917 to 1920 inclusive, have been in excess of \$15,000,000, which figure is an under-estimate of the actual amount spent. The achievements of the past few years must, in no small part, be attributed to this liberal research policy. It should be pointed out, however, that a large part of this sum was expended in attempting to re-discover processes already well known to German manufacturers and that a comparatively small proportion represents new discoveries of a fundamental nature. There have been new discoveries such as synthetic anthraquinone, but in the main these have been comparatively few.

A continuation of extensive research is necessary for the establishment of a competitive industry in the United States. It is a regrettable fact that there has been a tendency during the recent months to curtail research work. By following this policy manufacturers are endangering the future progress, and, in fact, the very life of the domestic industry.

Export Trade in Dyes

There is apparently a somewhat exaggerated opinion of the competitive strength of the domestic dye industry based wholly on the export of dyes, which has become widespread. Because of this somewhat general impression it may be well at this time to repeat many of the statements already published by the Tariff Commission.

If one should analyze the figures for exports of dyes up to January, 1921, without giving due consideration to other facts, only one conclusion would be possible, namely, that the domestic industry was well developed and capable of competing in the markets of the world. This is apparently what many people have done. But let us consider these export figures in connection with other existing facts. Germany, the world's pre-war source of dyes, was not able to resume operation in the world's markets during 1919 and 1920 notwithstanding the fact that the armistice had been signed.

As the United States had developed her coal-tar products industry more rapidly than that of European countries other than Germany, it was comparatively easy for domestic manufacturers to sell dyes to China, Japan, India and other foreign markets in the total absence of competition. The Tariff Commission, in its report for 1919, pointed out the fallacy of any deductions as to the strength of the domestic industry based solely on a consideration of export statistics, and that such deductions did not take into consideration the fact

that the domestic industry was deficient in the group of vat and alizarin dyes.

During the early months of 1921 domestic exports of dyes declined at a rapid pace. During 1920 the maximum export of aniline dyes was \$2,650,000 in March as against only \$306,000 in April, 1921. In other words, exports had declined to only 10 per cent. of the maximum shipped from the United States in 1920. This rapid decline has been attributed to the general business depression and in part it is no doubt due to this cause. An examination of the import trade of the consuming countries reveals the fact that there are other influences which have caused the cutting off of domestic exports of dyes.

The study of Japanese imports of dyes for the first three months of 1919, 1920 and 1921 shows that the imports coming from Germany increased from a little over 6,600 pounds in the first three months of 1919 to 72,500 pounds in 1920, and 432,000 pounds in 1921. This increase in the imports from Germany may be contrasted with a decrease in imports from the United States from 700,000 pounds in 1919 to 111,000 pounds in 1921, or only one-fourth the quantity imported from Germany during the same period. The imports into Japan from Switzerland show a decline similar to that from United States. A similar situation exists in China's import trade in dyes. It is quite evident from these figures that the domestic industry cannot as yet compete with Germany in the world's markets.

Percentage Domestic Production of Dyes Consumed

The Act of September 8, 1916, on coal-tar products requires that unless by September 8 of this year 60 per cent. of the domestic consumption is being produced in this country the specific duties of 2½ cents per pound upon intermediates and 5 cents per pound on dyes and other finished products were no longer to apply. In the case that over 60 per cent. of the domestic consumption was being produced in the United States the specific duties were to be reduced each year by 20 per cent., until they no longer applied. The census for 1920 shows that the domestic production was greatly in excess of 60 per cent. of the consumption. Under date of August 19 a communication was transmitted to the President pointing out these facts. A portion of the letter reads as follows:

"The production of the articles provided for in Group II (coal-tar intermediates) of the act referred to above, in the United States during the calendar year 1920, amounted to \$95,291,686, whereas during the same period the imports of these articles had a value of only \$751,448, or less than 1 per cent. of the value of the American production.

"The production in the United States during 1920 of the articles provided for in Group III (dyes and other finished coal-tar chemicals) amounted to \$112,165,865 in value, whereas the imports of these articles during the same period amounted to \$5,804,905, a little more than 5 per cent. of the American production. Furthermore, during 1920 exports of aniline dyes amounted to \$22,450,480, and exports of "all other dyes," consisting in part of synthetic dyes of coal-tar origin, amounted to \$7,373,111.

"It is, therefore, clear that during 1920 the domestic production of the articles enumerated in Groups I and III was much in excess of 60 per cent. of the domestic consumption. Although complete statistical evidence as to production is not available for any later period than the calendar year 1920, it is apparent that the importation of these products has not increased during 1921 to such an extent that at the present time less than 60 per cent. in value of the domestic consumption is supplied by domestic production. The facts, therefore, do not call for the issuance of a proclamation removing the specific duties under Section 501 of said act."

It is quite evident that the domestic manufacturers have greatly exceeded the requirements specified in the Act of 1916. This is an accomplishment of consider-

able magnitude in such a short time and one that the domestic industry may well be proud of.

Future Plans of the Commission

Although the main reason for the Commission's activity in the coal-tar products industry have been fulfilled, we do not believe that the industry has reached the basis that would warrant discontinuing the census of dyes. As the industry is at the present time passing through one of the most critical stages in its development it seems desirable that an accurate and detailed account be kept of the trend of the industry during the next few years. This seems desirable, not only for the good that the industry will derive from accurate statistical information during this period—as we have reason to believe that the domestic manufacturers have come to value highly these reports—but, on the other hand, it also seems desirable from a legislative standpoint in order that the effect of whatever legislation is passed by Congress may be accurately reflected.

The Tariff Commission in its decision to continue this work seeks and requests the continued cooperation of each individual manufacturer of coal-tar products in the United States. We have tried to make each succeeding census show more clearly the exact status of the industry in order that Congress might have a correct conception of the status of the industry in connection with pending legislation and incidentally to make the report of maximum service to the industry as a whole. The Commission is always glad to receive suggestions as to methods by which these reports may be improved.

In this connection in the preparation of the last cen-

sus we adopted the uniform system of nomenclature, as recommended by a committee of the American Dyes Institute and by the American Chemical Society. I understand that a report on this subject is to be published soon by the American Dye Institute. This standardization of the name of intermediates and its general application through the industry is a step in the right direction. However, it is only a bare beginning toward a much more complicated field, which is in still greater need of some form of standardization or revision. I refer to the existing nomenclature of the dyes. The Commission in each succeeding census has found an increasing quantity of dyes which could not be identified by Schultz tables. The quantity of such dyes increased from 1,281,000 pounds in 1918 to 2,060,000 pounds in 1920. In addition to this, difficulty has been experienced in the classification of dyes on account of the great variety of names applying to dyes of the same constitution.

I believe that it would be time well spent for organized consideration on the part of manufacturers of dyes of this matter of standardization and revision of the classification of dyes. I am sure that the Tariff Commission will be glad to cooperate and to aid in any way within its power in such an undertaking. Such a plan, if carried through to completion, would eliminate much of the mystery in the minds of consumers which surround the commerce in dyes. It would also go far toward gaining the confidence of the consumers and would demonstrate that the domestic type industry is not to follow the pre-war methods of the Germans in the sale of dyes.

Liquid Sulphur Dioxide in Oil Extraction

By Ralph H. McKee, Ph.D.

Professor of Chemical Engineering, Columbia University

SOMETHING over thirty years ago liquid sulphur dioxide was proposed as a solvent for fats and oils, and many attempts have been made to utilize this material in a practical way in the extraction of oils and fats, but so far no process sufficiently economical for commercial use heretofore has been found.

Attempts to extract oils and fats from vegetable and animal matter without preliminary treatment have been made at high pressure and at temperatures which, although below 100° C., are high considering the volatility of liquid sulphur dioxide; but an extended investigation has failed to show that any commercial success heretofore has been attained in efforts to make practical use of liquid sulphur dioxide as a solvent for animal or vegetable fats or oils.

Dehydration Essential

I have discovered that if the material from which the oils, fats or fatty acids are to be extracted is first subjected to a dehydrating operation, as by the use of heat and vacuum whereby the uncombined water present is substantially or wholly removed, the oils, fats or fatty acids present therein can be satisfactorily and economically extracted by the action of liquid sulphur dioxide and that the extraction can be effected at ordinary atmospheric temperatures and at a pressure only sufficiently high, about 45 pounds, to maintain the extracting agent in liquid form.

Applications

An important application of my process* is to the

extraction of oils from crushed seeds or nuts, such as linseed, flaxseed, castor-oil beans, peanuts, coconut and the like. In such extraction the crushed seeds or nuts first are dehydrated to remove substantially all of the free water present. The resulting mass then is extracted with liquid sulphur dioxide by the same procedure in which extractions ordinarily are made with volatile solvents, such as gasoline, the extraction apparatus, however, being made sufficiently strong to withstand the increased pressure of the sulphur dioxide vapor over that of the volatile solvents ordinarily used.

Procedure

The extraction may be made by the use of a single charge of sulphur dioxide, the treatment being continued until substantially all of the oil is dissolved but it ordinarily is advisable first to subject the material under treatment to the action of one charge of sulphur dioxide; then to draw off the solvent and dissolved content and repeat the operation one or more times until the oil is sufficiently extracted.

In some cases it is advantageous to utilize the liquid sulphur dioxide, used in treating one batch of oil-containing material, in the treatment of a second batch, the solvent dissolving a portion or all of the oil as desired from each batch. In this case, the solvent used in treating the material in one extractor can be transferred to and used in treating material in one or more other extractors.

The dissolved oil and solvent may be separated in any desired way either in the extractor in which the extraction is made or it first may be drawn off, the

*U. S. Letters Patent 1,376,211. Issued April 20, 1921.

separation in each case being preferably effected by distilling off and condensing the sulphur dioxide.

The oil and the meal from which the oil is extracted can be treated advantageously to remove the residual sulphur dioxide by blowing air or steam through until the solvent is eliminated. After this treatment, the oil is ready for bleaching or other chemical treatment before being marketed. For some purposes no further treatment of the oil after the removal of the sulphur dioxide will be necessary.

The sulphur dioxide obtained by blowing air or steam through the oil or meal can be recovered and condensed in any desired manner.

While the extraction may be carried out at ordinary temperature, it will be understood that the length of time of the treatment may be lessened by the application of heat to the material under treatment. When heat is used, I preferably employ a temperature of from about 20° to 25° C., but the degree of heat and consequent pressure in the extractor may be varied widely. The temperature selected will be determined largely by considerations of economy in the practice of the process.

Where I treat a batch of oil-containing material with more than one charge of sulphur dioxide, I prefer to treat the batch first at ordinary temperature but I may treat advantageously the batch the second time at a somewhat elevated temperature and, similarly, where I successively treat two or more batches of oil-containing material with a single charge of sulphur dioxide, I prefer to treat the first batch with the solvent at ordinary temperature but may advantageously treat the other batch or batches with the solvent containing oil extracted in treating the first batch at a somewhat elevated temperature.

The process may be used advantageously in the extraction of oils and fats from animal sources, such as fish, fish offal and the like, in which case the material is first dehydrated.

Another important application of the process is to the extraction of fatty matter from sewerage sludge however obtained, but an adaptation of such process is particularly important in extracting these materials from sludges produced by the process of sewerage treatment worked out at Bradford, England, and later modified by George A. Miles and R. S. Western. In this process, the sewage is treated with either sulphuric acid or sulphur dioxide, the sulphur dioxide being the cheaper and approximately as satisfactory as the sulphuric acid. This treatment brings about a separation of the suspended matter in the sewerage and the destruction of a large portion of the bacteria. As at present carried out, the sewerage sludge so formed is extracted with gasoline and yields considerable value in fatty matter.

I have found that liquid sulphur dioxide is a particularly good solvent for the fatty matter in sewerage sludge. A portion of the fats contained in such sludge is present as free oleic and stearic acids which are dissolved readily by liquid sulphur dioxide. In the use of my process, the sewage sludge is first dehydrated, the dried material extracted with liquid sulphur dioxide and the oils, fats and fatty acids separated from the solvent. The resulting fats and fatty acids are adaptable for the making of soap and for other uses.

The dried sludge which has been treated with the sulphur dioxide will, of course, carry a residual amount of this material. This can be moved by blowing air or steam through the extracted dried sludge and the resulting current containing sulphur dioxide gas can be

used to treat fresh portions of the sewerage, thereby materially lessening the expense of the treatment of the sewerage in accordance with the so-called Miles process. An important feature of my process is the utilization of the current of air or steam, used in blowing the dried extracted sludge without further treatment, in acidulating fresh portions of the sewerage and precipitating new quantities of sludge therein.

Method of Dehydration

The method of dehydration used naturally will vary with the material being dehydrated. Seeds of moderate size can be dehydrated and extracted without being previously ground. I have done this with peanut and castor bean half-kernels. For quantity production, however, these and other seeds normally would be ground to pass a 10-mesh sieve, and dehydrated by being placed on a warm surface with a current of warm air passing over it. For such a purpose, a Ruggles-Coles continuous rotary drier serves excellently.

Other forms of driers which are steam-heated are often of cheaper first cost, but not so economical of fuel or of so large a capacity. In drying such materials as seeds, the drier should be so regulated that the issuing dried product will carry approximately 10 per cent. moisture and not exceed a temperature of 80° C. A less moisture-content is, of course, an advantage in increasing the speed of extraction.

In the drying of sewerage sludge or other similar low-grade material as it is obtained from the filter press, the preferred procedure is to use a direct-heated rotary kiln so adjusted that the resulting dried sludge leaves the drier with approximately 10 per cent. of moisture and at a temperature approaching the boiling point of water. Higher temperature should be avoided.

Constitutionality of "Filled-Milk" Law to Be Tested

THE validity of the Wisconsin "filled-milk" law passed by the last state legislature, which provides that there should be neither manufactured nor sold in the state a product made from a combination of skim milk and coconut oil, will be tested by the Carnation Milk Co. and the Hebe Milk Co. in an action by them against the State Dairy and Food Commissioner. The complaint alleges that upward of \$1,500,000 is invested in condensaries and that the law is unconstitutional, and says:

"By reason of manufacture of this product it has been possible to utilize and place upon the market skimmed milk which has a large food value, but which has not been utilized heretofore for human consumption in a commercial manner; that the producer has not been paid by the butter manufacturer for said skimmed milk, and that a large number of producers furnishing milk to the condensaries of the Carnation Milk Products Company manufacturing "Hebe" have received from 90 cents to \$1 per hundred pounds for their skimmed milk, which would otherwise have been of no value except only at certain seasons of the year for stock feeding purposes to a limited extent; that in addition thereto the said Carnation Products Company has been able, as a result of the manufacture of "Hebe," to take from its producers all of the milk produced, whereas, if said product had not been manufactured it would have been impossible to have taken all of said milk because of the fact that the export trade on evaporated whole milk has fallen off on account of the conditions existing in European countries, the rate of exchange and the competition of Denmark, Holland and Switzerland."

A Survey of Material-Handling Equipment

Suggestions for the Use of Labor-Saving Devices in Chemical Manufacture

By R. H. McLain

Power and Mining Engineering Department, General Electric Company

THE diversity of chemical manufacture, with the peculiarities inherent in its various branches, forbids much of the standardization that characterizes the efficiency of industries concerned with the largely mechanical elaboration of matter, as distinguished from the combination and transformation of matter characteristic of the manufacture of chemical products.

The Chemical Plant

New discoveries in chemical science and the constant improvement of processes, which with the often corrosive and destructive properties of many chemicals, not only are a prolific source of obsolescence, but productive of a high rate of depreciation. So chemical manufacture in many of its branches, particularly as they relate to basic products, does not warrant factory construction of the type associated with volume production of small units and high labor cost.

At one extreme we have the cheap and scattered construction of explosives manufacture; at the other, the compact, substantial structures housing standardized apparatus and processes of a continuous type, with a minimum of hazard and permitting the maximum use of labor-saving devices in the transfer and treatment of solid and liquid materials.

Almost every chemical plant is the product of conditions peculiar to itself and represents often such rapid encroachment of demand upon the resources of production that the multiplication of buildings has created problems in factory transport that would have been solved easily had the plant been planned originally as a unit.

Often conditions of production require numerous isolated buildings compelling discontinuous progress of raw and manufactured material in the solid form when in volume not sufficient to warrant mechanical conveyance.

The motor truck and the industrial tractor have displaced the horse-drawn vehicle for outside work; for inside work ever-increasing labor cost has necessitated the replacement of antiquated hand-trucking methods with the labor and time-saving device represented by the industrial tractor of various types. Labor troubles and labor shortage have been the impelling motive to drive many employers to seek new labor-saving devices that will render them more independent of manual workers.

Fig. 1. The well-known standard truck is very convenient for short movements, fifty feet or less, but is of questionable economy at greater distances.



Fig. 2. With a hand-operated elevating platform truck having skids, one man can lift a load up to 2,000 pounds and can move it away. This system is advantageous in factories where the product is piled on skids one small piece at a time and the skids are removed by truck. Skids also may be handled by power machines.



Use of the more highly perfected industrial equipment requires for operation a higher class of workmen. Such men have not been so susceptible to radical influences as common labor, and thus introduction of more specialized equipment both reduces the volume of labor and elevates employment standards.

Concrete and paved factory yards and roads not only have contributed to efficiency in transport, but by making cleanliness around the plant less laborious, have enforced it as a habit.

Material Handling Equipment

We are concerned here with material handling equipment from a mechanical standpoint for the purpose of pointing out the possibilities of economies in material handling and the probable type of machine to which one may look for these economies. A number of rules for the application of various types of machinery will be stated, but this subject is so broad that it will be impossible to put in sufficient explanatory remarks to make these rules at all rigid.

The purpose of the illustrative matter is to suggest to the plant superintendent types of labor-saving equipment suitable to his requirements of production, with little attention paid to their mechanical construction to the end primarily that his resourcefulness to reduce production costs may be stimulated to do better what already may be done well and to improve what plainly may demand change.

The author recognizes the fact that the various types of machines continually are undergoing changes and developments which expand or modify their field of usefulness, so that no rule as stated ever can be considered as up-to-date. The field is so large and the opportunities for invention and knowledge are so great that it is impossible to give information which is, in any sense, to be considered final and correct.

Classification of Materials

For the purpose of this article, material may be classified as follows:

Solids may be divided into free-flowing material such as grain, sand, coal, etc., and non-free flowing material such as ore, asphalt and viscous and semi-solid materials. Liquids comprise oils and other material in the almost infinite variety naturally expected in the embracing field of applied chemistry.

Fig. 3. Portable power-driven conveyor is used for lifting and transporting medium-size packages. The conveyor easily can be transported to another section of the warehouse for similar duty. The capacity is about one ton per minute.



Fig. 4. Small portable conveyor used for lifting and transporting medium-size packages for a short distance. The conveyor is mounted on a box car, wagon, etc. The discharge height is adjustable.





Fig. 5. Portable conveyor or motor-driven tiering machine. The height of the boom is adjustable. Capacity one ton per minute. This device is useful for high piling of bags, bales, boxes, and rolls in a warehouse.



Fig. 6. An electric storage battery propelled load-carrying truck usually covered for about four to five miles per hour, capable of carrying about two tons. This truck is especially suited for handling miscellaneous cargo at steamship and railway terminals; also is adapted for peddling packages of 100 pounds and less in factories or assembly plants where the radius of operation is about 1,000 feet. It negotiates narrow aisles and sharp curves.

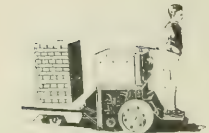


Fig. 7. An electric storage battery operated load-carrying truck, having a platform which is hoisted about three inches by power, is adaptable for use with "dead" skids or with "live" skids on wheels. It can handle one or two tons effectively within a radius of from 75 to 1,000 feet, and can be adaptably used in connection with a portable elevator as shown in Fig. 21, so that material can be piled up to about 15 feet. However, it is not to be used on smooth floors on account of its small wheels, and is adapted for speeds of from three to six miles an hour.

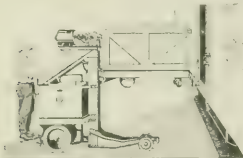


Fig. 8. This type of truck can be used for handling two tons at four or five miles an hour inside a building; manipulates short curves; can, on occasion, be used as here shown for hauling trail-ers as well. Its best use is for peddling miscellaneous small con-stituents of about 100 pounds each from various departments of a plant.



Fig. 9. This type of truck can be used for handling two tons at four or five miles an hour inside a building; manipulates short curves; can, on occasion, be used as here shown for hauling trail-ers as well. Its best use is for peddling miscellaneous small constituents of about 100 pounds each from various departments of a plant.

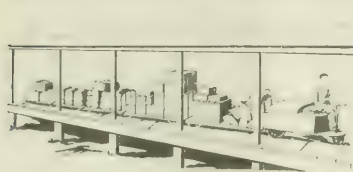


Fig. 10. This tractor may be used for pulling a weighing up to 18 tons at about three to five miles an hour inside a building, or for transporting material on skids arranged in tiers, and for moderately high piling. It is especially useful for peddling constituents of about 500 pounds per trailer within one-half mile radius. A system of this tractor with trailers corresponds to the system in Fig. 3 but is adapted for use in a warehouse or factory.



Fig. 11. This type of tractor may be used for pulling a weighing up to 18 tons at about three to five miles an hour inside a building, or for transporting material on skids arranged in tiers, and for moderately high piling. It is especially useful for peddling constituents of about 500 pounds per trailer within one-half mile radius. A system of this tractor with trailers corresponds to the system in Fig. 3 but is adapted for use in a warehouse or factory.

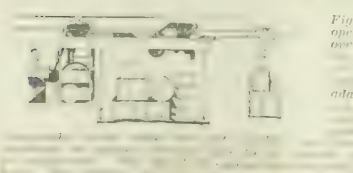


Fig. 12. Electrically-operated monorail overhead cranes can be used for lifting and moving material in a factory or warehouse. They are adapted for lifting and moving material in a factory or warehouse.

Package material may be divided into miscellaneous packages and uniform packages.

Miscellaneous packages may be divided into large packages weighing 300 lbs. and up, medium packages weighing 50-300 lbs., and small packages weighing 50 lbs. or less. Miscellaneous packages are intended to mean not only box, bale and bag material, but also pieces of material, such as beeves, shovels, chairs, etc.

Uniform packages of material also may be divided into large, medium and small as regards weight. This classification covers such material as comes in uniform bags, boxes or barrels, and hence is more readily adapted to specially-built and refined machinery. Bunches of bananas, for instance, would be considered in this class.

Classification of Material Handling Equipment

Material handling machinery may be divided into three classes: (1) common laborers using their hands or shovels, forks, etc.; (2) hand-operated machinery such as wheel-barrow, push-carts, two-wheel trucks, four-wheel trucks, etc.; (3) power-operated machinery. Power-operated machinery can be divided into three classes: (1) machinery for hoisting; (2) machinery for conveying; and (3) machinery for a combination of hoisting and conveying.

Hoisting machinery consists in general of platform elevators of either the stationary type such as are used in buildings, or the movable type for moving around in rooms; and bucket or chain elevators, chutes, gravity lowerators, whip hoists of some type or other.

Conveying machinery comprises: pumps with pipe lines; belt, bucket or screw conveyors; gravity roller conveyors; capstans for pulling cars; horse-drawn carts; electric storage battery platform trucks; electric storage battery locomotives either for running on rails or running on roads (sometimes called tractors); gasoline trucks and tractors; steam railway systems; boats.

Hoisting and conveying machinery consists of escalators, incline belt conveyors, high-lift elevating platform trucks, and especially electric overhead traveling cranes or locomotive cranes; also a combination of several of the types of machinery named under hoisting with others named under conveying could be used for combined hoisting and conveying.

Cranes cover such a wide variety of machinery that a further detailed description is desirable. Cranes may be divided into two classes, viz., for miscellaneous use, and for special purposes. Cranes for miscellaneous use cover electric overhead traveling cranes; electric cranes with revolving top; and steam, gas, and electric self-propelling locomotive cranes. Special purpose cranes include grab-bucket cranes, car dumpers, moving machinery for belt conveyors, magnet or tong cranes, drag-line excavators, electric and steam-operated shovels.

Proper Limits for Manual Labor

The main object of all machinery is to eliminate manual labor insofar as may be economical, and to make use of man for the higher purpose of directing the operation of the machinery.

The following rough guide points out the proper places to hope for economies in the use of machinery instead of men, unaided by any mechanical device:

1. Where three or four men are working together on one job for a couple of hours at a time, even though the work is not performed more than three or four times a week.
2. Whenever a man has to lift anything from his feet to a point above his head.
3. Whenever a man has to lift more than 50 lbs. from his feet to his shoulders.

4. Whenever a man has to lift more than 100 lbs. from his feet to his waist.

5. Whenever a man has to lift more than 150 lbs. from his feet to his knees.

6. Whenever a man has to stand in one place steadily moving material for over 30 minutes.

7. Whenever a man has to move material sidewise more than six feet, that is, two steps.

8. Whenever a man or a group of men, although moving around in a small radius, has to move more than 10 tons of material per hour.

If any of these limitations are exceeded there are certainly chances for some kind of machinery to show an economy and to relieve the men of the drudgery of hard labor.

Horizontal Transportation

For Miscellaneous Packages. Man-propelled machinery, such as wheel-barrow, two-wheel stevedore trucks, four-wheel trucks, etc., are generally economical for moving goods up to 75 ft., provided no one package weighs over 1,000 lbs., and provided the movement must take place between points of receiving and discharge which are not at all fixed. See Figs. 1 and 2.

If the points between which movements take place are fixed for any considerable length of time, medium size packages may be economically handled between distances of 10 and 1,000 ft. on belt conveyors if something like 10 tons per hour or more are to be handled long enough to warrant the movement of the machinery up to the points of use. See Figs. 3, 4 and 5.

For movement of material between points which are not fixed for distances ranging from 75-200 ft., electric storage battery trucks, built for low speed of four miles per hour indoors, are useful. See Figs. 6, 7 and 8.

For distances over 200 ft. and less than 1,500 ft., electric storage battery tractors with trailers running at about four or five miles per hour are useful, particularly where the movements are to take place between points which are not fixed. See Figs. 9 and 10.

For the same conditions but for points which are fairly nearly fixed, or at least confined to a trackway, an electric overhead monorail crane system with tractors and trailers would be applicable. See Figs. 11 to 13.

For distances between 1,500 and 5,000 ft., between points which are not fixed, an electric storage battery automobile of the road type, running at something like 8 or 10 miles an hour, would be useful. See Fig. 14.

Selection of Suitable Equipment

Once it is decided to eliminate manual labor, the question is what type of machinery is best adapted for the work and offers the best chances of showing economies. A great deal of business judgment, of course, is necessary in determining what constitutes an economy. In order for a machine to prove its acceptability it must not only show a profit in operation while it is busy, but the nature of its installation must be such that the machine can be kept busy a sufficient amount of time to pay an appreciable profit and also to pay for its first cost in a reasonable time.

In looking at the problem from this standpoint, all

Fig. 11. The electric overhead storage battery automobile truck for road use is especially adapted for moving loads up to 10 tons. It is easier to install than an electric overhead traveling crane and can be used in places where the latter could not be used.

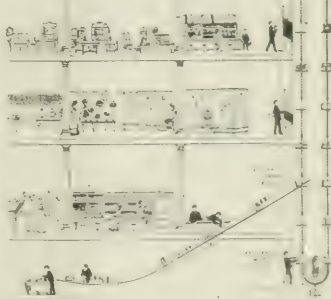
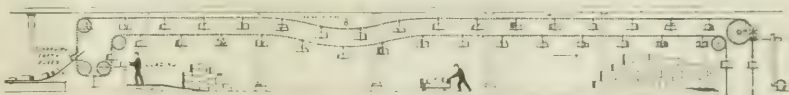
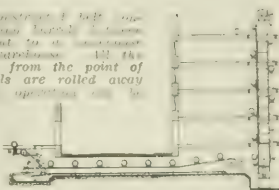
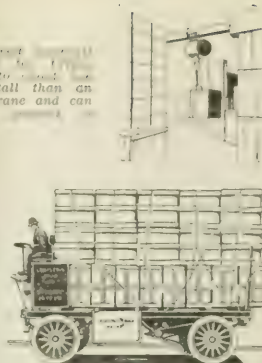
Fig. 12. The electric storage battery automobile truck for road use is especially adapted for moving loads up to 10 tons. It has a speed of 5-10 miles an hour and is built for a capacity of about 40 miles.

Fig. 13. The gasoline automobile truck and trailer is the best means for moving loads up to about five tons (weight on steel road). This system will probably be expanded to take care of most traffic within a radius of 30 miles.

Fig. 14. A specially constructed belt conveyor is shown in the illustration. It is a continuous belt of the type known as the "conveyor" and the operations are automatic from the point of delivery until the barrels are rolled away from the conveyor. The operation can be increased to meet the barrels, and the capacity is as high as 275 barrels per hour.

Fig. 15. A specially constructed belt conveyor is shown in the illustration. It is a continuous belt of the type known as the "conveyor" and the operations are automatic from the point of delivery until the barrels are rolled away from the conveyor. The operation can be increased to meet the barrels, and the capacity is as high as 275 barrels per hour.

Fig. 16. The electric overhead storage battery automobile truck for road use is especially adapted for moving loads up to 10 tons. It has a speed of 5-10 miles an hour and is built for a capacity of about 40 miles.



machinery divides itself pretty generally into three classes, viz., portable machinery, self-propelled machinery, and fixed machinery. It is reasonable to suppose that fixed machinery always will operate more efficiently and economically than either of the other classes, provided there is sufficient work at one location to keep it busy continuously. Portable machinery may be expected to be in general less economical and more fragile than fixed machinery and it can show its best economy where a small amount of work is to be done in one location and a small amount of fairly similar work at another location, and so on.

The sum total of work must be sufficient to keep the machine fairly busy and the expense of moving the machinery must be such as to be negligible compared to the amount of labor and expense it saves when it is set up at one location or another. Self-propelled machinery is generally more expensive than fixed machinery, but for a limited area it has the adaptability of portable machinery combined with the economies and ruggedness of fixed machinery.

For distances between 1 mile and 50* miles where the points of receiving and discharge are not fixed, the gasoline automobile geared for speed between 15 and 25 miles per hour, is useful. See Fig. 15.

For distances between 30 miles and say 200 miles, or, if no water transportation is available any distance, it is probable that the steam railway system affords the most economical transportation. The long distance haulage of material is undergoing radical development. The idea solution, which is every day approaching realization, is a combination of auto-truck with railway cars. The railway will carry the goods over long distances in demountable unit containers. These will be loaded or unloaded by cranes at terminals on or off auto-trucks, and thus distributed and collected locally. Such a system combines the ton-mile economy of a railway with the distribution economy of auto-trucks and the handling economy of cranes.

For distances of 150 miles and above, watercraft would probably be the most economical means of transportation if conditions are favorable for its operation.

Of course the proper economic line of demarcation between gasoline trucks, steam railway trains and boats introduces such a large question that no approximations should be allowed to influence a user, and any particular case should be thoroughly studied.

For Uniform Packages. Belt conveyors are useful provided tonnage is ten tons per hour or more between fixed points for long enough time to warrant installation of machinery. See Figs. 3, 4, 5, 16 and 17.

Chutes and roller gravity conveyors are also useful. See Figs. 18 and 19.

Of course for distances above 1,000 ft. the transportation means outlined for miscellaneous material will apply.

For Bulk Material. Belt conveyors are useful, especially where more than 20 or 30 tons per hour are to be handled between points which are fixed for more than an hour or two.

Screw conveyors are applicable to certain material which cannot be moved by belt conveyors.

Free flowing bulk material such as wheat, cotton, straw, etc., sometimes may be transported by pneumatic means.

Trucks with special self-dumping bodies, as in Fig. 20, find many special uses.

For distances of more than 1,000 ft. the means out-

lined for miscellaneous material will apply. Belt conveyors are being considered for carrying coal for five miles out of a mine.

Vertical Transportation

For Miscellaneous Packages. In the warehouse where stock is not shifted often and where high piling is necessary, the portable platform elevator is useful for packages from 500-2,000 lbs.; but the heavier packages are not handled so economically unless they are of such shape and consistency as to be rolled or moved fairly easily, such as rolls of paper, barrels, etc. See Figs. 21 and 22.

For heavy, unwieldy packages a locomotive crane with a whirler top is likely to be economical, as it affords means of making fast to the material by means of hooks and slings. See Fig. 23.

For small or medium packages inside a building, the portable conveyor is adaptable. See Fig. 5.

The electric overhead traveling crane is applicable to this type of work, specially where the material in a certain place is to be moved in and out every day, and also where exceptionally large pieces have to be handled. See Figs. 12 and 13.

Between the floors of warehouses, whip hoists attached to a winch, capstan or crane, or to the end of tractor, are applicable if the material is not on wheels, and if hoisting is to be done at one place only.

If the material is to be hoisted between the floors of buildings is on wheels, and if arrangements can be made to have a great deal of lifting done at one spot, the fixed platform building elevator and power-driven ramp (see Fig. 24) are available.

For lowering material from upper floor in packages up to 500 lbs., in weight a gravity chute or a lowerator is applicable. See Figs. 17 and 19.

For Uniform Packages. A belt or chain elevator such as a bucket elevator or barrel hoist is economical where a large amount of work is to be done. See Fig. 16. Also lowerators and chutes are applicable for this kind of work.

For Bulk Material. Skip hoists are economical where material is to be moved from a hopper to a hopper for capacities from 50-1,500 tons per hour and where the height or other physical conditions do not lend themselves to the use of a belt conveyor. For limited heights, the belt conveyor is the most economical, especially where a large tonnage, 100-2,000 tons per hour, is to be moved between fixed points continuously, or for five or six hours at a time. Such jobs as stowing coal in ocean boats come under this heading. Belt conveyors are limited to not over 20° incline to the horizontal.

Grab bucket hoists are useful for large tonnages moved between pile and hopper and are good for any height from 10 to 300 ft.

For lowering material gravity chutes are generally the most economical.

Special machinery, such as is adaptable for one particular type of package, for instances bunches of bananas or barrels, can be economically designed for handling large quantities of uniform packages. See Figs. 16, 17 and 24.

For Bulk Material. Car dumpers are useful for hoisting and dumping railway cars filled with coal, ore, limestone, etc. Special machinery has been designed for dumping wheat out of railway cars.

Belt conveyors have been used for loading wagons at the rate of 10 tons per hour, stowing coal in small boats at the rate of 10 or 20 tons per hour; also for such large jobs as carrying coal 1,200 ft. and dumping it into ocean-going steamers at the rate of 6,000 tons per hour. Coal and ore bridges and other grab-

bucket handling machinery, such as Hulett unloaders, steam or electric shovels, are used most economically in this work. Where conveying distance is to be quite long these machines are used in combination with a cable-road or auto-electric cars, or an industrial steam or electric railway system with hopper cars.

Aerial cableways are adaptable for certain work, especially where small-capacity-machinery is to be distributed over a wide area or where unfavorable physical conditions are encountered, such as rivers, gorges, railway tracks. A cableway would not be quite so adaptable for hoisting materials say 50 ft. and conveying it 50 ft. as it would for hoisting it 50 ft. and conveying it 1,500 ft.; whereas coal and ore bridges are better adapted for hoisting 50 ft. and conveying short distances, 30 to 500 ft., provided sufficient volume of material is at hand.

Bucket conveyors are capable of lifting 30 ft. vertically as much as 1,500 tons per hour. Smaller sizes can lift 200 tons per hour about 100 ft. See Fig. 25.

Combined Horizontal and Vertical Movements

For Miscellaneous Packages. Portable belt conveyors are useful provided tonnages are greater than 10 tons per hour and the work is to keep up between fixed points long enough to warrant putting the machinery in place. See Figs. 3, 4 and 5.

Systems of tractors and trailers in connection with platform building elevators are useful, especially where material is to be distributed over a wide area and provided the loads do not exceed say one ton for every trailer. See Figs. 9, 10 and 11.

The electric overhead traveling crane is adaptable for a large amount of work in a small area where large or unwieldy packages are to be handled. They are well adapted for factory operations. Monorail cranes are applicable where physical limitations of buildings, topography, etc., eliminate the use of the overhead traveling crane. See Figs. 12 and 13.

Locomotive cranes are useful where the work is of such a nature as to demand an electric overhead traveling crane, but does not continue in one building long enough to warrant the expense of an overhead traveling crane in every building or in every location where work is to be done.

For Uniform Packages. Portable belt conveyors are adaptable for medium-sized packages, provided the tonnage is greater than 10 tons per hour and the machinery can be used long enough to pay for setting it in place. See Figs. 3, 4 and 5.

Transportation of Liquids

Pumps and pipe lines are used for conveying liquids for any distance where flow is sufficient. However, wherever practicable gravity transportation should be availed of for liquid raw materials and liquids in process.

The variety of pump types employed in chemical manufacture and their material of construction reflect the great variety of characteristics of liquid materials required to be handled, ranging from corrosive and dangerous acids through the list of molten solids to the innocuous material, water.

The selection of the pump most suitable for the work to be done, its installation and operation constitute an important subject warranting separate treatment. In August CHEMICAL AGE, S. P. Miller, assistant superintendent of the Barrett Company, described the handling of liquids in coal-tar chemical manufacture. Each department of manufacture presents its peculiar problems, consideration of which at this time is without the purview of a survey of material handling from a mechanical standpoint.

Fig. 19. Special motor for electric hoists used in the hoisting of heavy materials. This motor is capable of lifting one ton, and is used for hoisting materials such as coal, ash, and crushed stone. It is generally used in a manufacturing power plant and can be loaded advantageously by a scoop conveyor such as shown in Fig. 20.

Fig. 20. The electric starting motor, with special body and instead of three or four miles an hour, is especially adapted for running in small aisles around sharp corners and carrying bulk material such as coal, ash, and crushed stone. It is generally used in a manufacturing power plant and can be loaded advantageously by a scoop conveyor such as shown in Fig. 20.

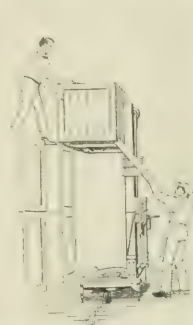


Fig. 21. A variation of Fig. 22 showing the frame and pulley of two men. These elevators may be operated by hand crank for low speed or by motor for more rapid speed.

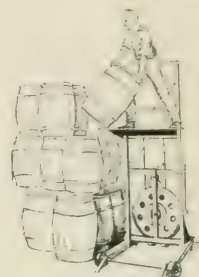


Fig. 22. A portable elevator capable of going up to any height, inside a building, heavy packages which he could not otherwise pile unassisted. As seen in Fig. 21, two men in team work can pile these heavy packages advantageously. The device will handle packages up to about 1,500 pounds and will take one trip in about two minutes.

Fig. 23. A simplified locomotive crane, such as that can be moved around by hand inside a building and used for high piling of heavy and unwieldy packages. A motor is used for hoisting.

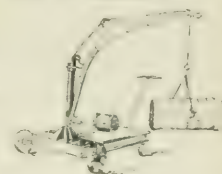


Fig. 24. The fired steam-driven American screw-conveyor, in overcoming a difference of level due to tide variation. It enables trucks to empty, empty, and load without additional labor.



Fig. 25. A portable electrically driven conveyor for digging coal out of stock piles and loading it into a wagon or truck. The capacity is about 100 tons an hour.



American Institute of Chemistry

IT required ten years of incubation for the project of an organization of chemists in the textile industries to acquire such strength as to command the approval of subordinate officers of the American Chemical Society in the section directly affected. The Dye Section of the American Chemical Society is concerned ostensibly with the science of tinctorial chemistry; the American Institute of Textile Chemists and Colorists with the application of dyes as a final step in the manufacture of yarn or fabric, as one branch of the textile industry.

The question arises: How long will it take to commend discretion as the better part of valor in the consideration and approval of men who hold themselves out as leaders of chemical opinion, of the project of an economic organization of chemically trained men? Salesmen of chemical products and manufacturers of chemical plant equipment, when they felt the need of organization, organized, undisturbed by any repressive influence that ignores the fundamental problems of the chemist's life—which indicates that delegated solicitude has the vices of its virtues.

Herbert Spencer promulgated one of the curiosities of phraseology in his definition of evolution which, for the benefit of those who believe in "one big union," and who close their eyes to evidences of misplaced faith, runs about as follows:

"Evolution is the movement from indefinite, incoherent heterogeneity to definite, coherent homogeneity."

This statement is more than a definition of a biological process. It is a fundamental natural law exemplified in everything that concerns the mind of man.

Chemists are proud of the accomplishments of their fellows and find their own chief reward in good work well done. They are deeply interested in everything that contributes to their status as professional men, but are spineless when it comes to the performance of any responsibility inculcated by the insinct of service.

Sheep-like they seek a leader to personify the aspirations that glorify ambition and find in men who hold themselves out as leaders an academic, professorial impracticality that would make them ill at ease in a crowd of chemical salesmen who do know how to go about to add dignity to and to demand respect for their calling.

That the great body of chemically educated men in America are without definite professional status is not because they do not want it, but plainly because a group of men thinks they don't want it; that such an economic problem does not admit of solution; that American chemists have a society that satisfies all the normal instincts of segregation; that chemists may form any economic organization devoted to the recognition of professional status they wish, but they shall be anathema to us; that such a project is a chimera of the disaffected; that we already have a professional organization in the secret society that functions as an intelligence division; that such a scheme would detract from the prestige of the American Chemical Society; that it might disturb the operation of the machine that nurses the shadow and the pretense of power and that considers organization paramount to any service demanded by the conditions of the time.

These gentlemen are right in holding aloof the American Chemical Society from any plan to form an organization for the cultivation of the professional status of the chemist, for it is a scientific society incompatible in its purposes with an economic organization of chemically educated men.

These gentlemen are wrong when they use their in-

fluence to condemn any movement which their emotions tell them might disturb their equanimity. Reason should impel them to interpret Spencer's definition and to view the formation of numerous specialized chemical organizations from the nebula of the American Chemical Society as its practical exemplification.

Encouragement of "one big union" not only affronts natural law, but magnifies the place and power of men of whom, while it is true "few die and none resign," it is not uncharitable to say that they do grow "stale, flat and unprofitable."

American chemists need to cultivate the attributes of leadership. This cannot be done alone in any organization—certainly not at all in one that ignores and condemns the natural aspirations of ambitious men. These can be encouraged, as in no other way, in a professional organization of definite purposes, precedents for which production chemists find all about them in the art and business of chemistry.

To Introduce Piette By-Product Coke Oven

Belgian American Coke Ovens Corporation, 25 Broad street, New York, has been incorporated in Delaware with an authorized capital of \$10,000,000 preferred stock and 200,000 shares of non-par common stock.

The board of directors comprise: Thomas F. Ryan of New York; Emile Franqui, Brussels, president of Banque d'Outremer and director of Societe Generale; F. S. Landstreet, president (associated with coal and shipping industry of the United States for many years); Hector Prud'homme, Brussels, vice-president; Herbert H. Vreeland (identified with many industries of New York, Belgium and Portugal); Oliver Piette (coke oven inventor of Belgium and for many years vice-president and manager of Franco-Belgian Coke Oven Corporation); G. H. Walker, president of W. A. Harriman & Co., Inc.; Adolphe Stoclet, ex-president of Franco-Belgian Coke Oven Corp.; Lambert Jadot, director of many Belgian and Portuguese mining corporations.

Mr. Ryan and Mr. Franqui have been associated for many years in extensive developmnets in the Belgian Congo. Some three years ago, Mr. Franqui directed Mr. Ryan's attention to the Piette coke ovens, which for many years have given the best results of any thus far developed. The further refinements of the by-product coke industry made possible by the Piette ovens are claimed to be of far-reaching importance, especially in economy of fuel costs. The carbonization appliances are designed in units to suit the needs of large or small fuel consumers.

The American corporation will be supplied from Belgium with an organization of technical experts who have been trained in this industry for a number of years and there will be added American engineers and executives for the introduction, construction or operation of the Piette by-product coke ovens and other carbonization appliances.

Expansion in the lard substitute manufacturing facilities of the Cooknut Corp., Baltimore, Md., W. R. Spruill, president, embraces the construction of a 3 and 4 story reinforced concrete main building, 56 x 104 feet, and power house and machine shop, to cost \$885,000.

Recoil of Legislation That Affronts Economic Law

IF we are to take without some salt of hesitation the heated and persistent attacks of the Federal Trade Commission upon the Chicago packers, those men are malefactors and public enemies, for whom literal crucifixion would not be too severe punishment; but sweeping denunciations are quite too common in these times, and it is wise to stand by an ancient practice in giving the accused the benefit of doubt.

The Packer, the Fruit Grower and the Canner

About the end of February of last year, the Commission felt quite proud and happy in having obtained something, namely a "consent" decree, barring the wicked Big Five from further engaging in the grocery business; but now the California fruit growers have decided that the missile has miscarried and has hit themselves destructively. They say that they are facing ruin because, with large crops and heavy marketing costs, they cannot get their product to the distribution centers.

The packers used to be their stronghold, taking the product along with the meats in their refrigerator cars and leaving it where and in such quantities as needed; but now the growers are faced by high rail rates, and the banks heartlessly tell them that it is impossible to make or to carry loans on crops which cannot get to market. The canners are, of course, in like difficulty with consumers of fresh fruits, for they cannot work without the raw material, nor does the old jingle operate that "we can what we can and we eat what we can't." Canning and eating are estopped together by the one barrier of no carrying.

It is the plaint of the producer, and he ought to know what is pinching him, just as the sight of ripe tomatoes reddening acres along the rail through parts of Maryland and Delaware speaks eloquently of the wastes which keep the cost of living high and keep so many ramping like locoed cattle. In this instance, the fruit growers have prevailed so far as to get from the Federal judge who signed the decree against the packers a preliminary hearing and thus an opportunity to ask at least for some modification.

The Wholesale Grocer

The middleman is not so sure of the expediency of such action, and he wants to know where he will stand. The associated wholesale grocers, earnestly desiring competition as interpreted in their own favor, are said to fear that relaxing the decree may practically open the entire field for the packers "to develop a food trust of vast proportions," while the packers themselves may have felt from the first that the immutable laws of trade and human nature are on their side and therefore they could afford to wait.

It has been said—and never has been denied, nor has it been imputed to them as one more sin—that the packers utilize every bit of the hog except his final squeal of protest. It is said by the packers in rebuttal—and, apparently in despair of successfully criticizing it, it has not been denied—that they do on a great scale the slaughtering and cutting up which, before them, was done on a small and local scale, each producer doing his own "killing."

What these men do is what the steel-makers and other great producing concerns do. They follow "quantity" and standard production, thereby getting the last effectiveness out of labor and material and cutting out wastes

more and more effectually. If an imaginary thousand armed giant were to pick up food products from the soil where grown, and, reaching over all intervening distance were to hand them in at the door of each individual family—if such a thing could become real, there can hardly be among all the uninformed and unthinking, one person dull enough not to see that the costs of living would fall and that, after the disturbed grumblers had had time to readjust themselves, everybody would be among the gainers.

To reduce the number and costs of the handlers and middlemen, to shorten distances, to smooth out friction, to bring towards each other the producing and the consuming ends of every industrial line on earth—this is a dictum of sound political economy, and it is or should be the aim of every man who applies a rule of sanity to the problems of life.

Class Condemnation of Efficiency is at the Cost of the Consumer

Meat products must move in refrigerator cars, and the packer supplies these. Other perishable food products must have the like vehicle or be restricted to a short radius of distribution. The packer, it is charged, takes the "grocery" perishable along with the meat, thus obeying the rule of filling in the chinks in space, and he thus carries and delivers both. How, and against whom, does he sin?

The middleman may see his own undoing, and if he does he sets up a wail; the retailer feels like doing the same in respect to the chain store. That store does just what the Woolworth idea began and has carried to such tremendous volume; it substitutes a small profit rate on a great mass for a large profit on a small quantity; it acts on the rule of giving the utmost instead of the least possible service for a dollar.

One might draw a graphic diagram in the form of a triangle, with producer, middleman and wholesaler, and then retailer, at the angles, while the consumer fills the interior space. He is the largest factor, since he is everybody. All the others are playing to catch and hold him, and he, without quite realizing either the fact, or the significance of the fact, is playing *them*, and he is vastly bigger than them all.

Indeed, a pursued analysis shows that if there is any sin he is the chief sinner; if he can grab the "ball" of low prices he neither thinks nor cares who or how many he puts out of the game and sets hunting for another field.

The aim of the stolid and bat-eyed labor unionist, that victim of years of false teachings, is still to extort the last penny of wage and give in return for it the very least possible service; yet when he goes out to buy, does anybody suppose he has not heard of Woolworth and the chain store, and that he does not now (admitting that only a short time ago he did just the opposite) go where he can get the most for the wage he spends? So, if we are to mutter curses at selfishness, let us turn them upon the general consumer, that universal sinner above all on whom agitators have wished to throw a statutory tower of Siloam.

Human nature being streaked with both selfishness and folly, there is always a temptation for the less successful in the battle of life to envy the more successful and accuse them of unfairness. Were all men literally "equal" in every respect, it might be true that differences in achievement imply and prove "unfair methods of competition."

Did Caruso wrong and rob the millions who did not receive his gift? Does Edison wrong the rest of us who were not designed and equipped to scent out and harness Nature's secrets? Does the genius wrong the clodhopper, the energetic hinder the lazy, the ambitious injure the one who differs from the quadruped chiefly in standing upright? Labor unionism virtually declares the affirmative, but that is because the incompetent must be flattered into membership and dues-paying.

Emulation Marks the Divinity of Man

It is falsely said sometimes that "competition is hell." The law of survival of the fittest may seem heartlessly cruel, but it is the implacable and immutable law of Nature, and when it is rightly interpreted it moves towards two desirable results: the means (and really the sole means) of elevating the standard, by setting a goal for aim and effort, and, as at once more important and

more beneficent, eliminating unfitness by spurring and lifting up the unfit.

An unalterable uniformity of reward would mean and would produce a uniformity of effort and achievement, and therefore progress would be impossible for lack of moving force. Success in this life means the proper adaptation of means to ends—of right means to right ends, if the success is genuine. The presumption must always be that those who have achieved large results have done so by breadth of mind, comparative keenness of foresight, and unusual energy.

In our patent laws we still continue, with little accusation, one monopoly whose purpose is to stimulate inequality for the general welfare; but outside of that we clamor for and too largely enact statutes whose unwritten preamble is that size is sin and property is robbery. If this is true in any degree in any country on earth, it is least true in this land of waiting opportunity

American Institute of Textile Chemists and Colorists

FOLLOWING upon a meeting on August 26 at the Engineers' Club in Boston, Mass., of prominent textile chemists in the Boston territory, an invitation signed by William D. Livermore, chief chemist, American Woolen Company, Lawrence, Mass.; Winthrop C. Durfee, consulting and manufacturing chemist, Boston, Mass.; George A. Moran, chief chemist, Pacific Mills, Lawrence, Mass.; Walter M. Scott, chief chemist, Cheney Brothers, South Manchester, Conn.; Walter S. Williams, chemical engineer, Mt. Hope Finishing Company, North Dighton, Mass.; William R. Moorehouse, National Aniline & Chemical Co., Boston, Mass.; Russell W. Hook, textile chemist, A. D. Little & Co., Cambridge, Mass.; Harold W. Leitch, chemical engineer, M. T. Stevens & Sons Company, Franklin, N. H.; Warren H. Whitehill, chemist, Brightwood Manufacturing Company, North Andover, Mass., and Louis A. Olney, Lowell Textile School, Lowell, Mass., was issued to textile chemists and colorists to meet at the Chemists' Club in New York on Sept. 13 to form an organization of men engaged in textile chemistry, to which about 60 chemists responded.

At this meeting Prof. Louis A. Olney was appointed chairman and outlined in a comprehensive discussion the development during the past ten years of the subject of an association of chemists in the textile field for which there was successful precedent in the British textile industry.

Such organization as was initiated is a logical consummation of highly specialized technical enterprise and could not be satisfied, as had been suggested, by the addition to the already cumbersome organization of the American Chemical Society of a section devoted to dyeing, bleaching and finishing, which being of the character of a craft are out of place in a strictly scientific society. Furthermore, the heterogeneous membership of the American Chemical Society, its numerous sections of diversified and conflicting subjects, the confusion and distraction of interest and meagre sectional attendance at its general meetings, had gradually confirmed the conviction that a useful organization of textile chemists must be independent in its structure and management of the American Chemical Society. Independent and self-sufficient organization was imperative if a body devoted to the realization of the needs of a great industrial field were to be created.

The consensus of opinion as regards organic connection with the American Chemical Society confirmed the statement of Benjamin T. Bock in his address

before the National Association of Cotton Manufacturers, presented in May, 1921, *CHEMICAL AGE*, as regards the development of the research spirit and the establishment of a research institution in the textile industries, to wit: "Direction of research cannot be left to a committee."

Prof. Olney outlined the purposes of the organization, whose name was accepted as that of the American Institute of Textile Chemists and Colorists, as follows:

I—To promote the technical interest of its members in the properties and application of dyes and the processes of scouring, bleaching and finishing.

II—To develop a closer relationship between theory and practise in the application of dyes and other chemicals used in the textile industry.

III—To serve the textile and color industries by developing standard methods of testing dyes and analyzing textile materials in general and of standardizing systems for these tests and recording their results.

IV—To encourage research work along textile chemical lines.

V—To encourage and supervise the establishment of a complete textile chemical laboratory.

It was proposed membership of the Institute be divided into 3 classes, to wit:

I—Regular or active members, who should possess as qualifications for membership a thorough technical training and at least 5 years of actual experience in textile chemical lines.

II—Junior members, who would include students and apprentices.

III—Sustaining or corporation members, who would include textile manufacturing concerns and also manufacturers of dyestuffs and chemicals used in the textile industry and who would be called upon to supply funds to support the research work.

In the general discussion of the attitude of the American Chemical Society toward the new organization, Dr. R. Norris Shreve, secretary, Dye Section, A. C. S., declared himself heartily in favor of it and saw in its plans and purposes nothing inimical to the interests of the American Chemical Society. Prof. Olney, also an officer of the Dye Section, emphasized his loyalty as demonstrated by his position as an officer of the Dye Section and his membership of twenty-five years.

A committee of five was appointed to report to the inaugural meeting in Boston on the occasion of the Textile Exposition, Oct. 31-Nov. 5, on working plans for the latest satellite of the American Chemical Society.

Edward O. Benjamin, formerly chief chemist, International Oxygen Co., now engaged in consulting work, has transferred his office from 568 Broad street, Newark, N. J., to 15 Park Row, New York.

Seventh National Exposition of Chemical Industries

SURPASSING efforts of prior years and eclipsing any display of specialized industrial activity ever held in New York, the International Exposition Co., 342 Madison avenue, New York, has reason to be proud of its enterprise and of the loyalty, in a time of business depression and of close-to-the-bone living, of manufacturers of chemical equipment and chemical products.

The displays of about 400 exhibitors on one level surmounted by the great arched canopy of the 8th Coast Artillery Armory gave an impression of vastness which found concrete realization in convenience and comfort to both exhibitor and visitor, notoriously lacking in the Grand Central Palace shows of preceding years.

Nothing can be said disparagingly of the Armory, save its inaccessibility, for it outclasses any structure in New York in its suitability for exhibition purposes; but dissatisfaction on all sides was found with the location, which on the penultimate day of the Exposition was expressed by an overwhelming majority in a vote of 176 out of a total of about 400 exhibitors to hold next year's show near the hotels and railroad terminals at Grand Central Palace.

The extreme dilution of the idly curious did not prevail at the Armory, the attendance during daylight hours being characterized by intelligent interest and seriousness of purpose gratifying to the business-seeking exhibitor. Many exhibitors desire a popular attendance, but the great majority prefer the class that comes for a purpose other than the satisfaction of shallow curiosity. Notwithstanding that the 7th Chemical Exposition in the hinterland of the Bronx served effectively to increase the density of the latter class of attendants, the inconvenience incident to inaccessibility condemned the location with the great majority of exhibitors who had no voice in its selection.

The relatively reduced number of exhibitors of chemical products, due probably to the prevailing stagnation of production, gave to exhibitors of chemical equipment a prominence which is expressed in the following table:

Class.	Number of Exhibitors.	Per Cent.	Approx. Total.
1. Chemical Machinery and Manufactured Supplies not Chemical	209	52	...
2. Chemical Products	131	33	...
3. Chemical Service and Publicity	60	15	400

Abbé Engineering Co., 50 Church St., New York, had a complete display of its patented pebble mills, rotary cutters, ball mills, tube mills, filter presses, mixers, vacuum pumps, pressure blowers, laboratory pulverizing mills and acid pumps. The display was in charge of H. F. Kleinfeldt.

John F. Abernethy, 708-10 Myrtle Ave., Brooklyn, New York, showed examples of the lead-burner's art in lead-lined tanks, lead coils, lead acid containers and jugs and other chemical equipment made of lead. The exhibit was in charge of John F. Abernethy, assisted by John F. Kierman and J. J. Cooney.

American Hard Rubber Co., 8 Mercer St., New York, had an imposing display of chemical equipment in hard rubber, comprising tanks, pumps, piping and utensils characterized by resistivity to the action of corrosive chemicals required to be handled in such equipment. A. M. Ackerman was in charge.

Atlantic Engineering Co., 150 Nassau St., New York, displayed liquid weighing systems for chemical and steam plants. Messrs. Quinn and Leinert demonstrated the automatic character, accuracy, and wide availability of the Leinert automatic gravity scale and the Morehead system of steam drainage and boiler feeding.

The Bahnsen Co., 437 Fifth Ave., New York, exhibited the Bahnsen humidifier, and demonstrated its independence of water pumps, air compressors, etc., in providing proper atmospheric conditions. R. E. L. Morefield, E. S. Burnett, A. P. Kramer and L. J. Cadmus were in attendance.

J. T. Baker Chemical Co., Phillipsburg, N. Y., displayed a representative assortment of "Baker's Analyzed Chemicals" arranged in pyramid. The exhibit was in charge of W. P. Fitzgerald, chief chemist.

Joseph Baker Sons & Perkins Co., 29 West 43d St., New York, exhibited the Werner & Pfeiderer "Universal kneading and mixing machines for mixing of materials from a heavy or viscous state to dry powder work, the machines being equipped with various types of mixing blades, jackets for heating or cooling and in capacity ranging from 1/4 to 2,650 gallons. Features of the exhibit were complete set of laboratory machines in operation, small commercial size machines for heavy mixing; mixers for dry powders and liquid work. A. J. Vollrath, vice-president, was in charge, assisted by J. C. Caley and S. D. Gridley.

Beach-Russ Co., 50 Church St., New York, showed a line of rotary vacuum pumps, rotary pressure blowers, tempering furnaces, rivet heating furnaces, acid pumps, liquid pumps, pulverizing and grinding machinery. Howard C. Russ, C. A. Beach, A. T. Beach, E. Beach, D. A. Riley and H. J. Wilson were in charge of the exhibit.

Christian Becker, Inc., 92 Reade St., New York, displayed analytical chainomatic balances, specific gravity chainomatic balances, bullion scales—2,000 ounce capacity, torsion scales—for cream testing, grain testing and general laboratory work. The following representatives were in attendance: W. C. Symington, A. T. Millroy, J. W. Wetz, J. K. Dunn, S. W. Hess.

Celite Products Co., 11 Broadway, New York, featured two major products in filter-cel for filtration and Sil-O-Cel for heat insulation with numerous samples of products showing the clarifying efficiency of the former, together with a small filter press in operation, and a small electric furnace used to demonstrate the heat-insulating properties of the latter. Among those in attendance were A. W. Knight, E. S. Crosby, A. S. Elsenbatt, R. L. Warburton, C. J. Parsons, A. H. Fertig and P. C. Durbin.

Commercial Solvents Corporation, 17 East 42d St., New York, displayed prominently a chart of the various uses of butanol and an incubator in which was shown the bacterial action essential to its production from corn by fermentation. Products of the Weizmann (patented) process were shown in samples of butanol, acetone and ethanol. In charge of the exhibit was Horace E. Hall, aided by P. G. Mumford, vice-president; H. E. Hall, sales manager; C. L. Gabriel, Western sales manager; T. F. Carty, manager New York office; Chas. Bogin, plant chemist.

E. I. du Pont de Nemours & Co.'s exhibit was confined to a suspended Du Pont Oval beneath which in a commodious area were provided desks for the transaction of business by the Dyestuffs, Chemical Products, Dry Color and Pigment, and Acids and Heavy Chemicals Divisions of the organization—which business-like arrangement, particularly in contrast with its elaborate demonstration of the preceding year of the relationship of dyestuffs and explosives, gave the impression of liquidation and the deck cleared for business. The appeal was to the trade and not to the public, doubtless realizing the fact that only those impelled by a sense of duty would travel to the Bronx.

Eimer & Amend, 18th to 19th St., Third Ave., New York, had an attractive display of aluminum ware, Bailey & Pickel extraction apparatus, B. & L. and Spencer microscopes and refractometers, Bingham & Green plastometer for testing of viscous and plastic materials, Brooks' rotating autoclave, Coors' porcelain ware, Duboseq, Wesson & Kober colorimeters, E. & A., A. D. L. & Whatman filter papers, E. & A. mercury sealed stopcocks, Fleming & Fisher Com-

reagent bottles, Hortvet cryoscope for determination of water in milk, MacMichael viscosimeter for the testing of oils, varnishes and glues, replaceable unit furnaces, resistance pyrometers, silica ware and Wysor polishing and grinding apparatus. The exhibit was in charge of Theodore Taistra, assisted by C. G. Amend, W. A. Eimer, F. W. Shulenberger, E. P. Churchill, R. S. Chalfont and G. Grille.

General Ceramics Co., 50 Church St., New York, displayed its line of acid-proof stoneware and fused silica and featured one of the largest stoneware vessels ever made in this country; a centrifugal pump in which both housing and impeller are made of chemical stoneware; a stoneware exhaust fan for handling corrosive gases and a stoneware kettle with agitator suitable for sulphonation, nitration or similar purposes. A model of a modern nitric acid plant and also a working model of a storage system for acids were demonstrated. Two full-sized stoneware scrubbing towers, complete in every detail, formed the entrance to the exhibit and in order to demonstrate the mechanical strength of acid-proof stoneware piping, the hand rail was made entirely of this ware. The exhibit was in charge of P. C. Kingsbury, assisted by H. Boyer, R. S. Beecher and K. J. Peters.

General Chemical Co., 25 Broad St., New York, contributed with other members of the Allied Dye & Chemical Corp. family to the most attractive group of exhibits of the Exposition. This member featured Baker & Adamson Reagents, the new Herreshoff furnace for roasting ores and Hard-N-Tyte for concrete and mortars. James M. Keating was in charge, assisted by G. G. Ackerson, manager of sales; L. de B. Lovett, G. N. Vardy, J. E. Wilson, M. M. Biddison, W. J. Kramer, R. P. Silva, W. R. Chappell, J. H. Libbertson and S. B. Greene.

International Salt Co., Scranton, Pa., displayed samples of all grades of salt used in industry. The booth was in charge of W. T. Chisholm, and H. J. Osborn, district sales manager, and George A. Walter, production manager.

Maurice A. Knight, East Akron, Ohio, exhibited acid-proof stoneware in great variety of design, size and purpose, and showed impressively the diversification of structure and function of which this resistant material is capable. In attendance were Maurice A. Knight, owner; Chas. Dennison, superintendent; Samuel J. Baril, manager New York office, and G. Gordon Urquhart, manager Philadelphia office.

National Aniline & Chemical Co., 21 Burling Slip, New York, in an Egyptian setting in which Dr. L. J. Matos rivalled the attainments of Imre Kiralfy, visualized the progress of the American dyestuffs industry. Intermediates and "National" colors and samples of the application of the latter embellished the scene. In a colorist's laboratory, the use of dyes was demonstrated. The decorative effect was heightened by Dr. Matos, assisted by a group of technical experts and salesmen, among whom were: F. J. Gainey, C. C. Knights, H. J. Daigneault, S. W. Wood, A. E. Wood, F. J. Allen and E. B. Nickerson of the Philadelphia office, W. R. Moorehouse and W. W. Rowse of the Boston office, and W. H. Willard of the Charlotte office.

National Rosin Oil & Size Co., 90 West St., New York, exhibited samples of rosin, rosin oil and rosin pitch in various grades and also commodities, viz. varnishes, greases, printing inks, canvas belting, waxes, paper cables, etc., in which these products enter. Richard Bender and R. Lathrop were in attendance.

Newark Wire Cloth Co., 222-228 Verona Ave., Newark, N. J., showed wire fabrics in great variety of weave, weight and purpose and exhibited a micrometer microscope for measuring the mesh of wire cloth made as finely as 840-mesh, designed by A. A. Campbell, who, with E. J. Koon, L. C. Campbell and J. C. Campbell were in charge of the exhibit.

Parks-Cramer Co., Fitchburg, Mass., showed its complete system of industrial heating by oil circulation with a Merrill Process unit, capacity 25,000 b. t. u. per hour and a typical arrangement of equipment as applied to the heating of jacketed vessels. Also shown were air conditioning equipment, heat and humidity regulator, high duty motor-driven humidifying head. In charge of exhibit were Alexander B. McKechnie and Frank G. Bell, assisted by Thayer Francis, J. W. F. Macdonald, Stuart W. Caldwell, A. A. ...

Powhatan Mining Co., Woodlawn, Baltimore, Md., displayed samples of raw asbestos and a chart showing process of manufacture of Powminco asbestos, also shown in its various forms, thoroughly fiberized and free from incompletely shredded material and impurities, for use as

a filtering medium. Fred A. Mett, assisted by Frank Mett and Joseph A. Bauhaus, was in charge.

Rhodia Chemical Co., 89 Fulton St., New York, the American projection of the Societe Chimique des Usines du Rhone, France, with plant at New Brunswick, N. J., exhibited a complete line of its intermediates, dyestuffs, medicinal and photographic chemicals, in which were featured resorcin, ethyl chloride, dimethyl sulphate, hydroquinone and monomethyl paramido phenol sulphate. In attendance were Dr. Max Mueller, J. A. Buechler, Dr. A. Zimmerli, C. F. Kelly, Dr. P. R. Hickerson, Dr. R. C. Lyon and A. C. Robertson.

Sarco Co., Inc., 14 Park Place, New York, displayed working units of Sarco temperature regulators in actual control work; also Sarco steam traps, radiator and blast traps, strainers and recording gas calorimeters. The exhibit was in charge of C. Wells and E. J. Ritchie, with Messrs. Barfus, Burke, Corder, Minor, Mooreman, F. C. Perkins and J. E. Perkins, also in attendance.

Semet-Solvay Co., Syracuse, N. Y., displayed a model of the Semet-Solvay by-product coke oven, together with a full line of Semet-Solvay chemicals and paints, the former including solid and flake calcium chloride, salt, phenol, benzyl chloride, benzaldehyde, ammonium sulphate, ammonium chloride, ammonium hydroxide, ammonium bicarbonate, yellow prussiate of soda, salicylic acid, methyl salicylate, tello, benzol, solvent naphtha, anhydrous calcium chloride, sodium nitrite, etc. Combined with the Semet-Solvay exhibit and under the direction of E. C. Scott, was the exhibit of the

Solvay Process Co., Syracuse, N. Y., which featured the basic alkalis produced by this subsidiary of Allied Dyes & Chemicals, Inc. This family exhibit occupied the middle of the Armory at the intersection of two main highways and commanded by its area, prominence and unity of decorative effect the attention of every visitor. The utilization of the products of coal and common salt and the varied arts of heavy chemical manufacture were visualized as the bases of material civilization, with its adornment represented in the dye-embellished products of numberless crafts. The Solvay Process Co. was represented by J. Cooper, W. H. C. Grimes, G. F. Kimber and R. C. Werner.

Union Sulphur Co., 33 Rector St., New York, displayed samples of crude sulphur. W. N. Wilkinson and W. M. P. Taylor represented the company. The Union Sulphur Co. was the pioneer in the development of the Louisiana sulphur deposits whose exploitation have constituted one of the modern industrial wonders of the world.

United Filters Corp., 65 Broadway, New York, displayed its three types of filters, viz., the "United" plate and frame press, the Sweetland leaf-type filter and the "American" continuous vacuum filter. An interesting feature was a single disc four feet in diameter taken from the "American" filter and motor-driven, to show construction and operation; also a single cast-iron shaft section and disc taken from a large 8 ft. 6 in. diam. machine, showing the latest developments in vacuum filter construction, the most striking feature being the new roller cake discharger which replaces, for many purposes, the scrapers formerly used. Robert C. Campbell, E. J. Sweetland, L. D. Thompson and C. M. Stanley were in attendance.

U. S. Industrial Alcohol Co., 27 William St., New York. Combined with its exhibit was that of its subsidiary, U. S. Industrial Chemical Co., concerned with the elaboration into numerous chemicals of the by-products of alcohol manufacture. In addition to various grades of alcohol, the parent company featured "Alcorub." The chemicals comprised ethyl ether, distilled iodine, tincture of iodine, potash materials, potassium iodide, ethylene, ammonia salts, carbon dioxide, ether for anaesthesia, ether commercial; mixed fertilizers; diethyl carbonate; ethyl benzoate, ethyl myrurate, ethyl cyanide, ethyl formate, ethyl fumarate, ethyl isovalerate, ethyl lactate, ethyl malate, ethyl maleate, ethyl monochloracetate, ethyl oxalate, ethyl propionate, ethyl salicylate, iso amyl acetate, iso amyl formate, iso amyl isovalerate, iso amyl propionate, iso butyl acetate, iso butyl butyrate, iso butyl formate, iso butyl isovalerate, iso butyl propionate, iso propyl oxalate, methyl formate, normal propyl acetate, normal propyl isovalerate, normal propyl n-butyrate, normal propyl propionate. B. R. Tunison was in charge.

D. Van Nostrand Co., 8 Warren St., New York, featured the standard text-books and technical treatises devoted to the science and art of chemistry published by it. Representatives in attendance were E. M. Crane, A. G. Heany, H. Marshall and P. B. Healy.

Personal Items

Howard M. Raymond, dean of engineering, Armour Institute of Technology, has been appointed acting president.

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Dr. V. H. Gottschalk, formerly director of research, American Cotton Oil Co., is now with the Western Electric Co., Hawthorne, Chicago, Ill.

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Dr. Harry F. Lewis, A.B. and A.M., Wesleyan University, and Ph.D., Tilden, Illinois, has been elected associate professor in chemistry at Cornell College.

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William Cooper Procter, president, Procter & Gamble Co., Cincinnati, Ohio, has been appointed a member of President Harding's Unemployment Conference.

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Charles E. Foster has been appointed New England sales manager of the Calco Chemical Company, 35 Hartford Street, Boston, Mass.

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Dr. Raymond F. Bacon has resigned as director of Mellon Institute to take effect Jan. 1, 1922. Dr. E. R. Weidlein has been appointed acting director.

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Dr. Reuben S. Tour has been appointed professor of chemical engineering at the University of Cincinnati to succeed Dr. O. R. Sweeney, who has resigned because of ill health.

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J. A. Fairchild, formerly chemist for the Cuban Portland Cement Co., Mariel, Cuba, is now with the Missouri Portland Cement Co., at its Kansas City, Mo., plant.

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James L. Howe, Jr., who has been for three years assistant professor of chemistry in Washington and Lee University, has accepted the professorship of chemistry in Hangchow Christian College, China.

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Dr. E. M. A. Chandler, formerly with the Dicks-David Co., Chicago Heights, Ill., is now with the Industrial Chemical Laboratory Co., dye intermediates, Hammond, Ind.

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Calvin Stitt, formerly manager of Katzenbach & Bullock, Boston, and later Chicago, has been appointed manager of the heavy chemicals department of A. Daigger & Co., Chicago, Ill.

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Litter & Allen, Inc., 233 Broadway, New York, is the successor of the chemical department of Robert Grant at the same address, of which D. H. Litter and J. P. Allen were the directors.

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P. M. Garrod, formerly manager, chemical and color departments, National Sales & Trading Co., Cleveland, Ohio, is now western sales manager, A. Wilhelm Co., dry and pulp color makers, Reading, Pa.

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Dr. C. G. Derick, chief of research, National Aniline & Chemical Co., Buffalo, New York, has resigned to engage in consulting practice as C. G. Derick & Co., Buffalo, New York.

* * *

R. H. Anderson, formerly American agent, Chemical Works Madoery, Ltd., Basle, Switzerland, has taken over the offices of that concern at 165 Broadway, New York, where he will conduct business independently in

pursuance of its plan to supply the trade through agencies.

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Dr. J. M. Bell succeeds Dr. F. P. Venable as head of the department of chemistry at the University of North Carolina. Dr. Venable, formerly president of the university, has resigned as head of the chemistry department, but retains his professorship.

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Charles A. Lambert, works manager, Hattiesburg, Miss., naval stores plant of the Hercules Powder Co., has been awarded the degree of Chemical Engineer by Pennsylvania State College from which he graduated as industrial engineer in 1910.

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Ernest E. Simpson, overseer of the bleaching department, Amoskeag Mills, Manchester, N. H., has been appointed assistant to superintendent W. K. Robbins, and to assistant superintendent Miles R. Mofatt of the dyeing and bleaching department.

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John Johnston, formerly secretary, National Research Council, has been appointed to the professorship of chemistry, Yale University, where expansion of courses in industrial chemistry is expected under the enlarged program of chemical instruction at that institution.

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Dr. Robert P. Fischelis, formerly lecturer on commercial pharmacy, Philadelphia College of Pharmacy, has been appointed dean, and professor of the theory and practice of pharmacy, New Jersey College of Pharmacy, Newark, N. J.

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Frank Zvernia, formerly plant superintendent, Capital Refining Co., Washington, D. C., will have charge of the new plant of the Cooknut Corporation, Baltimore, Md., now in process of equipment by the Brecht Co., St. Louis, Mo.

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W. F. Caldwell, recently designing engineer for Meigs, Bassett & Slaughter, chemical engineers for the Tubize Artificial Silk Co.'s plant at Hopewill, Va., is now field engineer for the Gulf Refining Company, at Port Arthur, Tex.

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Former department heads of the old house of Laidlaw-Kelly & Co. have organized under the direction of J. Schanzenbach, the J. Schanzenbach & Co., 74 Cortlandt Street, New York, dealers in chemical raw materials and products.

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Edmund C. Champion, for the past nine years connected with The American Agricultural Chemical Co., as division superintendent of its northern division, and assistant manager of its four works in the vicinity of New York, is now engaged in independent practice as a consulting industrial engineer, specializing in commercial fertilizers and allied products, with office at Elizabeth, N. J.

E. D. Winkworth, president of the Semet-Solvay Co., has been elected executive vice-president of the Solvay Process Co., Syracuse, New York. Executive management of both concerns will be centered in Mr. Winkworth as the result of this action. E. L. Pierce, president of the Solvay Process Co., and vice-president of the Allied Chemical & Dye Corporation, will make the New York offices of the latter concern his headquarters.

Industrial Notes

The Lamie Chemical Company, with plant at Huntington, W. Va., has appointed Matheson and Atkinson, 120 Broadway, New York, sole distributors of its products.

* * *

Rogers, Brown & Co., 30 Church St., New York, have been appointed sole American agents of the Norsk Aluminum Co., Christiania, Norway, for the sale of aluminum.

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The Furness Corporation, 343 South Dearborn street, Chicago, C. Furness Hatchy, president, is engaged in the development at Clarksville, Mercer County, Pennsylvania, of a deposit of high-grade fuller's earth.

* * *

A 10-20 per cent. reduction in wages and salaries, effective October 3, in all Eastman Kodak plants has been announced by George Eastman. Business depression and competition from European cameras and German motion picture films are cited as reasons why production costs must be reduced.

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Arkansas, Louisiana and Texas Development Co., capital \$6,000,000, has been incorporated by E. A. Frost, Shreveport, La., J. S. Cullinan, Houston, Tex., and John Walsh, Washington D. C., to build a pipe line from the Monroe, La., gas field to St. Louis, Mo., and other contiguous industrial centres.

* * *

Increased consumption of yeast as a dietary accessory has made necessary the construction by the Fleischmann Co. of a third plant in Baltimore, Md., which will have a daily capacity of 12 tons of yeast and will cost for site, building and equipment, about \$3,000,000.

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The Air Reduction Co., 342 Madison Ave., New York, is having plans prepared by Francisco & Jacobus, 511 Fifth avenue, architects, for its new plant on property recently acquired on Ridge avenue, Pittsburgh, for the manufacture of commercial oxygen, etc. It will be one and two-stories, 80 x 140 ft., and is estimated to cost about \$250,000 with machinery.

* * *

National Slag Products, Ltd., is a Canadian Corporation organized to make tile and structural material from slag obtained from the Steel Co. of Canada, Ltd., near whose plant at Hamilton, Ontario, the new factory will be built. Management will be in the hands of E. J. Robertson, who claims for slag tile superior advantages in cost and properties of manufacture over ordinary terra cotta.

* * *

The Pyrene Mfg. Co., 17 West Forty-ninth street, New York, has purchased the six-story, reinforced-concrete factory at Belmont avenue and Peddie street, Newark, N. J., heretofore owned and occupied by the Aluminum Goods Mfg. Co., to be used as its main works in the Eastern district. The New York plant on East Thirty-second street will be removed to the new location. The Aluminum Goods Company will remove its plant from Newark to its main offices at Manitowac, Wis.

* * *

The momentum of Frank A. Sieberling's return to the rubber industry, after his deposition as president of the Goodyear Tire & Rubber Co., gathers impetus in his offer of \$750,000 to the receivers of the Portage Tire &

Rubber Co., Barberton, Ohio., for the property and assets of that concern, following upon his acquirement of the New Castle Rubber Co., New Castle, Pa., whose name he changed to the Lehigh Tire & Rubber Co. Mr. Sieberling is said to control the Star Tire & Rubber Co. of Akron and to be negotiating for the Republic Rubber Corporation of Youngstown and for the Marion Rubber Co., Marion, O.

* * *

At a meeting of representatives of the leading manufacturers of chemical plant equipment at the Chemists' Club, New York, on September 17th, it was decided to form an Association of Chemical Plant Equipment Manufacturers. The object of this association is to further various interests of these manufacturers, which, it is believed, can be promoted more satisfactorily by action as a group rather than as individuals. The Organization Committee comprises: J. George Lehman, chairman, Bethlehem Foundry & Machine Co.; Paul O. Abbé, Paul O. Abbé, Inc.; A. A. Holmes, E. B. Badger & Sons; Dr. C. H. Kimberly, Schutte & Koerting Co., and P. C. Kingsbury, General Ceramics Co.

* * *

A cooperative agreement has been effected between the United States Bureau of Mines and the Central of Georgia Railway for an investigation by the Ceramic Experiment Station, Columbus, Ohio, of the white clay and bauxites through central Georgia along the railroad right-of-way. R. B. Gilmore, formerly ceramic chemist with the Vesuvius Crucible Co., Swissvale, Pa., and H. M. Kraner, formerly ceramic assistant of the Bureau of Mines, have been assigned to this work. Preliminary tests on the effects of low calcination temperatures on the colloidal content of Georgia white clays have been made. By calcining Georgia clay to from 500 to 600°C. the absorptive properties were reduced to those of the English china clay, without materially reducing its plasticity.

* * *

The Louisiana Celotex Co. has begun operations in the first unit, costing \$500,000, of its plant across the Mississippi from New Orleans, in the utilization of bagasse in the manufacture of fibre wallboard, which enterprise represents a great advance over the use of these waste materials as fuel in sugar mills for which purpose it is an inferior fuel because of high moisture-content and used thus only because of the necessity of disposing of it. The plant site comprises 50 acres with a river front of 1,700 ft. The manufacturing plant is 125 x 1,000. The present plant is the first of a series of units that will be erected as rapidly as possible, and in a few years a large part, if not all, of the bagasse produced by the 200,000 acres of Louisiana sugar land will be consumed by this industry. The officers of the company comprise: president, B. G. Dahlberg; vice-presidents, J. K. Shaw, C. G. Muench, and T. B. Munroe, and C. F. Dahlberg, treasurer.

POSITION WANTED

CHEMICAL ENGINEER, 26, industrial and engineering research, supervision in the fields of synthetic compounds, plastics, by-product coke and gas manufacture, petroleum and natural gas production; desires connection along general lines of past experience or, preferably, commercial position. Has modern business training, business experience and good personality. Address: R. K., care of CHEMICAL AGE.

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LLOYD LAMBORN, *Editor*

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Economics of Coal Tar in America

The Growth and Present Status of the Business of the Assembly and Elaboration of Coal Tar and the Distribution of Its Products.

By R. P. Perry

Vice-President, The Barrett Co.

WHAT is "coal tar?" The dictionary gives as a generic definition the brownish-black, more or less viscid liquid produced as a by-product in the manufacture of gas or coke. But what is it commercially? Tar is the name applied broadly to raw material as different in quality as the proverbial chalk and cheese.

It is a material fully as variable in quality as the widely differing petroleum from light Pennsylvania to heavy Mexican; but unlike petroleum, the value of a particular tar, even at any one period of time, is not secured by distilling it by itself. The best values in a well-rounded tar refining business follow from the blending of at least two or more tars of quite widely varying characteristics which do not come from the same gas works or coke-oven plant. This is an important assertion which should be examined in detail.

Tar Classified

There are three main classes or groups of tar in the United States, viz., coke-oven tar, gas-works tar and water-gas tar. Each of these groups has many varieties, so that while a given tar belongs in general in one group it may nevertheless in certain characteristics belong in another group entirely, and require individual treatment. I wish to point out briefly the characteristics usually most important to tar distillers, and their common variations.

Characteristics of Coal Tar

The water-content varies generally from less than 1 to 8-10 per cent. and sometimes over 40 per cent., and is not only of no value but a nuisance expensive to remove.

Free carbon runs from less than 1 to over 35 per cent.,



R. P. PERRY

Vice-President, The Barrett Company

based on the dry tar. It is the portion insoluble in benzol and determines the use of the pitch which forms 50-75 per cent. of the tar.

The viscosity, i. e., its fluidity at a given temperature as compared to water, determines the use of tar for many purposes as road coatings, for saturation, paints, etc.

The yield of oil distillate in quantity and quality in making roofing pitch varies from 16 to 31 per cent. and has much to do with the value of tar when roofing pitch is the objective.

Likewise the yield of oil distillate in making very hard pitch determines the value of tar, especially when, as is often the case, the normal pitch outlets are over-supplied and oils become the main product of tar distillation. The yield of oil distillate under such conditions varies from 35 to 55 per cent.

The yield and quality of pitch depends on the free carbon and other characteristics and runs from 50 to 75 per cent. of the dry tar.

Chemical Constituents

I have not overlooked the special chemical constituents, such as naphthalene, anthracene, tar acids, etc., nor have I forgotten the great coal-tar chemical industry which we are trying to build up in this country to replace supplies from Germany and other foreign sources. The development of this industry is of national importance; but as a rule (there was a temporary exception during the war) these chemical constituents play only a relatively small part in determining the value of a gallon of tar, because the total amount of these chemical products recovered from any particular tar represents usually less than 10 per cent. of the particular tar and generally less than 2 per cent. of the total tar worked by our company.

The largest single item, naphthalene, as recovered in practice represents generally less than 4 per cent. of any individual tar. While all these refined chemical products are important and do play a part in determining tar values, nevertheless their part is less in comparison than the part which tar itself plays in determining the values obtained from coal in gas or coke operation. Like tar, they play the minor role of by-products. When the quality of tar is very poor, we often have tried to get the gas-works manager to change his operation a little so as to improve the tar but to the best of my recollection we have yet to get any answer other than that tar is a by-product and must come as the gas operation makes it.

The benzol and toluol-contents of most tars are so negligible and they are obtainable so much more easily and cheaply by washing the gas that we have not for years recovered benzol and toluol from tar oils except during the war and in a few special cases where the recovery is incidental to other products. The main values must come from the 90-95 per cent balance of the tar.

Water Content of Tar

The water-content of tar, frequently running up to 6 or 8 per cent. and sometimes to over 40 per cent., is more of a factor than most gas companies appear willing to recognize. In the case of many tars the last few per cent. and sometimes more only can be removed commercially by a distilling process. In this connection it is well to remember that on account of its high specific and latent heat of vaporization it requires about 5 times as many B.t.u.'s to vaporize a unit of water as compared to a unit of tar oil.

From the tar-distiller's point of view, it is not only the fuel that is wasted, but the extra and special apparatus that it is required to install to dehydrate the tar and the separate and extra storage facilities, which go to make up a part of the extra cost of working a wet tar. This extra cost sooner or later comes out of the gas companies in the price they receive for their tar. One of the largest gas companies in the country recently has been complaining to us of the low price it receives for its tar, while at the same time it has been delivering, not as the exception, but as the rule, for over a year tar containing from 8-25 per cent. of water, which costs more than a cent per gallon of tar to remove when all factors are taken into account.

Comparison of Tars

Coke-Oven Tar.—Turning, however, to the proper constituents of tar (which water is not) we find that most coke-oven tars are moderate in free carbon (generally from 5-10 per cent.) but extremely variable in viscosity (from 1½-10 times water) and extremely variable in oil distillate (from 18-31 per cent. for roofing pitch to from 38 to 55 per cent. for very hard pitch).

Gas-Works Tar.—The gas-works tars vary greatly, depending on the type of retorts, whether horizontal or vertical, as well as other factors, such as the temperature of carbonization and the size of the charge of coal in the retort. Vertical-retort tars are low in free carbon (generally 2-4 per cent.), low in viscosity and high in oil yield. Horizontal retort tars on the other hand are high in free carbon (generally 15-25 per cent.), high in viscosity and low in oil yield.

Water-Gas Tar.—Water-gas tars are very low in free

carbon (generally about 1 per cent.), high in yields of oil of an entirely different character and usually of lower value than coal tar oils. Water-gas tars usually are low in viscosity although recently some of them have become so high in viscosity as to be almost useless to us for the purposes for which they were bought.

Pitch Content

Pitches vary substantially in quality with the free carbon-content of the tar, ranging from those made from very "low carbon" tars, such as vertical retort tar and water-gas tar, which are very brittle and easily affected by temperature changes, through coke-oven pitches which are somewhat less brittle, to the other extreme of pitches made from very high-carbon tars, such as many of the horizontal retort tars. These latter pitches lack life and ductility and are very difficult to melt and in fact some of them are so "dead" as to be of no value for most of the known uses of pitches.

Independent Distillation of Coal Tar

The above distinctions are of paramount importance in any project of a gas company to distil its own tar, for it is impossible, with negligible exceptions, to make suitable and satisfactory tar products from individual tars, such as come from individual gas works or coke-oven plants. Why so? The answer leads us to the following considerations:

The business in tar products had not developed to its present volume of importance because of a natural popular demand for these products. With the exception of creosote oil for timber treatment, every coal-tar product in this country has been marketed in a large way only as the result of a long up-hill campaign for years, with the expenditure of millions of dollars for advertising and development work.

Instead of the public crying for tar products, we have had to educate them through engineers, architects and chemists to see that by proper combination of various tars and proper refining methods we can produce standardized commodities which will give high satisfaction over a long period of years.

Permit me to remind you of the old days when tar was a nuisance which must be dumped in the river or ocean to get rid of it. The early tar distillers who made pitch for roofing purposes had to compete from the very beginning against strong and cleverly handled promotion on the part of the asphalt companies, who spread far and wide a glamor around the word "Asphalt."

One of the most important reasons why the early tar distillers nearly failed in their effort to market their products was the fact that these distillers, operating as local units, had not developed laboratories and testing methods and blindly thought, as some gas engineers do today, that tar was tar.

Some Roofing-Business History

To be more specific, let me take the case of coal-tar pitch for so-called gravel or slag roofs on substantially flat surfaces. These roofs are constructed by building up a number of layers of coal-tar saturated felt, cemented together with coal-tar and having a surface coating of coal-tar pitch, in which is embedded gravel or crushed slag as a wearing surface.

In the early days these roofs sometimes failed and got in bad repute. Why? Often because the distillers thought tar was tar and that any tar would make satisfactory roofing pitch. So some of them made pitch out of high-carbon gas-works tar and although the pitch was tough in a way, it did not have enough cementing qual-

ity, nor did it have a long life. As a result, the plies of felt came apart and the gravel or slag came loose on the surface and washed away—blocking the gutters and leaders and soon the roof leaked.

In other cases the local tar distillers (corresponding to the local gas works) made pitch out of water-gas tar and got a nice fluid pitch, which the roofers liked at first because it spread so easily and a ton went so far. But alas, this very thinness was its undoing. Much of the pitch soaked into the felt, the plies came apart, the pitch on the surface seemed to dry up and disappear and the roof leaked. Gradually and only as the local tar-distilling companies combined, compared notes, established testing methods and studied the problems, there developed the surprising fact that tar was not tar and that good roofing pitch could only be made in most cases by blending various tars. In one or two cases the gas companies, then in the distilling business, tried to get the same result by filtering the excess free carbon from their coal tar, but they soon found the cost was prohibitive.

Even after knowledge of the differences between tars was developed, the roofing-pitch industry was still threatened by a corresponding lack of standardized methods of applying the roofing materials. There were in different parts of the country a considerable number of skilled roofers of the highest standing, but their work was in competition with unskilled or "fly-by-night" roofers, who used the cheapest pitch available (generally water-gas pitch) and took their chances of being out of the way by the time the roof leaked.

The asphalt industry industriously spread around tales of such roofs which had failed. They presented laboratory tests to show that coal-tar pitch was more volatile and brittle than asphalt and fell into the error of assuming and asserting that these laboratory tests explained why a few coal-tar pitch and gravel roofs had failed. They disregarded of course the history of the large majority of cases where practical experience had shown that on substantially flat surfaces a properly constructed coal-tar pitch and felt roof gave by far the least cost per year of service.

The competition, however unfair, was nevertheless real and our company took another most important step forward. It was not enough to make good pitch,

we must educate the architects and the public to recognize and insist on a reliable and standardized roof construction and so we developed Barrett Specification Roofing, with its 20-year bonded guarantee, on which in advertising alone we have spent about \$1,000,000. I say advisedly, if we or some other tar distillers operating on more than a local scale had not taken these steps, the gravel-roofing industry would not exist appreciably today in America as relatively it does not exist in England or on the Continent.

No individual gas company would have had the suitable variety of tars to make the mixtures which we

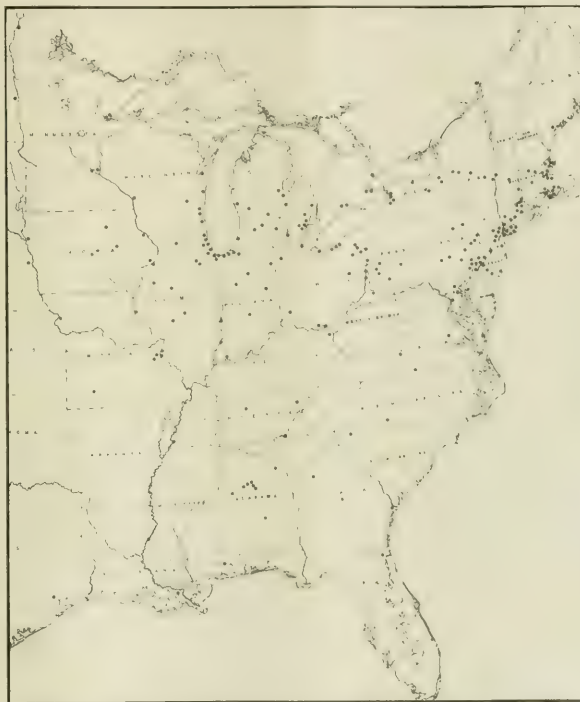
found absolutely necessary if the product was to succeed and no individual gas company would have gone into the wide-spread study of the roofing industry or have been willing to spend the money we spent to educate the architects and owners to specify good materials, well put together to make durable roofs. Our Barrett Specification business is now a large one but we are just beginning to get back a fair return for all of these years of work. We are getting some of the returns of course through other gravel roofing business because The Barrett Specification has set the standard. The less expensive roofs must measure up towards it even if they do not insure its high standard.

I have gone at some length into this development of gravel

roofing and roofing pitch because it illustrates concretely the necessity of tackling a national problem on more than a municipal basis. We have built up the business, the standards and the knowledge and I would be foolish to say that now it is built up an individual gas company could not to some extent "steal our thunder" and make a satisfactory roofing pitch, but the making of the product is not the end of the story—it must be sold and that brings me to an important economic point.

Some Political Economy

Gas companies and other public utilities are accustomed to lead the life, not by any means a bed of roses, of so-called natural monopolies. They take it as a matter of course nowadays. They know that with two or three gas companies in the same city there would be competition, which is said to be the life of trade but the death of profits.



Each Dot Indicates a Plant Producing Over 2,500 Barrels of Coal Tar Per Year

For years, until the war, this country was fed up politically to insist on free competition and let the devil take the hindmost, but it has been gradually dawning a little on the more enlightened people that the failure of the hindmost is in the end a charge on society, which the consumer eventually pays for. It is now seen that there is "something," to say the least, in the merits of large companies when the public can exercise reasonable control over them.

Look now if you will at the map, where each dot represents a producing plant of more than 2,500 barrels of tar a year, and assume that most of these gas companies and by-product coke companies decide to erect tar-refining plants.

Promoters of certain patented distilling apparatus will enter at this point and assure you that their equipment costs little, occupies practically no space and will turn out everything from soup to nuts without more than the occasional attention of one eye of an unskilled laborer. I will merely say in passing that in our experience it has not been quite so simple. Let us fill out, however, the picture by adding the expensive item of selling forces, practically unknown in the gas business, and then turn to the question of the relation between local supplies and local consumption.

It would be fine for the gas companies and ourselves if the consumers of tar products would only localize themselves to suit us, but they don't. There is far from a balanced condition. Nearly every large city and every large steel center (sometimes these two come together, as at Chicago) produces tar beyond its local consumption. Some large producing centers, such as Birmingham, Alabama, have relatively no local consumption. What does this mean? It means either bringing together the tar at the points which as a matter of experience have proved the best distilling centers, or shipping the surplus finished product from one territory to another, or to some extent both, and this would bring the different gas companies reaching after the same trade. You will no doubt wish to estimate what would be the probable net result from the business under such conditions.

Tar for Road-Building

What I have described above in detail as to the technical development of gravel roofing and roofing pitch is also true of the use of tar for roads. Years ago tar was used in a small way for sidewalks and roads but the results were so variable and unsatisfactory that it was abandoned. Sheet asphalt took its place for roads and cement or flagging for sidewalks. The trouble, of course, was partly unscientific application but also largely the variable and unsatisfactory tar products resulting from trying to use any old tar which was locally cheapest. We have put in 18 years in developing a satisfactory product for macadam roads and are proud of our achievements. I say again advisedly that I do not believe tar products for roads would ever have been developed so rapidly and successfully in the United States if it had not been for the national promotion and advertising which it has been possible for a nationally organized company to provide.

In England

Reference sometimes is made to the English experience where local gas companies in a great many cases do work up their own tar for roads and other uses, but conditions there are quite different. In the first place, it is there a recognized commercial practice for the

various companies to act in combination with each other as to prices and sales in a way which the law does not permit here. The country is small, compact and on the whole densely populated. They do not have local competitive supplies of asphalt for roads and roofing as we do.

Most important of all, they have in Wales and on the Continent a substantially local market for practically all of their excess tar in the form of briquette pitch, which we do not have in this country because of the still abundant and relatively cheap bituminous coal. "The burden of pitch" is one of the most serious problems of the tar industry in this country. We have developed some uses for hard pitch here which they do not have abroad but we greatly miss the briquette pitch outlet which they enjoy. At times we have been able to export some briquette pitch from Atlantic coast points, but after the freights and handling charges are deducted there is little left.

In spite of spending large amounts of money in research and development work, the pitch uses, especially profitable uses, have not developed as rapidly as the increasing tar production, due to changing from beehive to by-product coke ovens. On more than one occasion we have had in stock pitch representing the product from more than 2,000,000 barrels of tar. The difference between English and American conditions as affecting the tar industry is as wide as the ocean between.

The Coal-Tar Chemical Industry

Getting the coal tar chemical industry started in the United States in a large way was made possible only by the war. The Germans had too much head-start and when we or others developed individual products, the Germans cut the price on these particular products to less than the cost of our raw materials and made it up on the price they charged for other products we were not yet producing, all of which is a matter of history.

In some lines we had not only the German but also the English competition, with little or no tariff protection. I remember years ago, when the demand for tar acids was strong, we installed a plant at New York to extract the acids from the coal tar oils, but no sooner had we gotten started before the foreign price dropped to several cents under our cost and naturally we shut down the plant. It stayed shut down until the war shut off the foreign supply.

Shutting off this foreign supply taught a great lesson to the consumers of coal-tar chemicals in this country, who for years had refused to even consider the dangerous condition of having our dyestuffs and military high explosives made abroad or from foreign materials. Those who had opposed reasonable protection saw it would have been far better to pay a slightly higher price for a time instead of placing this business abroad and choking the industry here to death. Most of them are now willing to see a reasonable measure of protection for the coal-tar chemical industry.

The development of the coal-tar chemical industry in this country has called for research work on a scale so large that no single gas company or group of gas companies was in position technically to undertake it. We have spent on research and development work during the last five years over \$1,500,000. It is no great trick to be able to make naphthalene or to extract tar acids from tar oils, but to be successful the chemical industry cannot pick off one item at a time and by itself. It requires a comprehensive and large-scale development and operation.

Anthracene

It is not very hard technically to make crude anthracene, but it is very hard to do it cheaply enough to compete with foreign anthracene and it is a great big job to develop a use for the other products recoverable at the same time with anthracene so as to get a reasonably low cost for each. Anthracene, by the way, is not present in water-gas tar and the recoverable anthracene represents only about 0.3 per cent. of the average coal tar. We have found in most cases it can be recovered at a low cost only when worked up with several other products and that means quite a large plant and a large and steady supply of tar to make it worth while.

The result is we can undertake it only in plants combining the tar supplies from several producers. It would not pay any, except very large tar producers, to undertake such products; and again, if they were produced by a number of individual gas companies or groups of companies you would introduce the element of cost of selling and competition with each other, which would in my opinion more than offset the profits some think is lost by selling to the tar distiller.

Competition in the Tar Business

I am a believer in the equilibrium theory of business and think it works in the tar business as well as in others. In the first place, there are several large tar distillers and there is a real competition which raises the price of tar to a fair market value. When it goes too high, considering the market for finished products, we have to stop buying and let the other fellow take it and see if he can year after year make money out of it.

The tar producer here gains the advantage of a stable market in that the price of tar is measured by known conditions and possibilities of the market for finished products where the laws of supply and demand govern the situation. It is only the large organization with a diversified line that has facilities for acquiring this true measure. The producer of tar at all times enjoys a price based upon the keenest competition between the large distillers. The over-production is taken care of and extreme peaks and hollows in the price line, unavoidable in a purely local distribution, are unknown.

Large as is the production of gas works tar in this country, it only represents 30 per cent. of the total. Any comprehensive plan of tar disposal must take into account the larger by-product coke-oven supplies, whose owners may not have the same point of view as some of the local gas companies.

Variation in Tar Production

The variation in tar production would be a serious handicap to any operation dependent on local supplies. The gas companies are naturally more stable in their operation than the coke ovens but gas fashions change and go from coal gas to water gas, to by-product coke-oven gas, to vertical oven gas, and back again, bringing in their train changed and sometimes dismantled gas plants, as well as widely varying kinds of tars.

As large tar distillers, we overcome this difficulty in most cases by strategically located distilling plants, drawing supplies from several producers. This means paying some freight but in the long run it has proved better than the experiment we have ourselves tried of plants individual to large single producers. I have in mind particularly one plant we built at a cost of several hundred thousand dollars, where the prospective tar production was over 500,000 barrels of tar a year. The local conditions suddenly changed, the tar became so

valuable for local fuel that it was worth more than for distilling purposes and our main unit never has been operated.

Synthetic Organic Chemical Manufacturers Association of the United States

The latest body in the American chemical firmament is that denominated in the above title and represents the enterprise of men to give permanency to chemical manufacture in America in the fields of dyestuffs, intermediates, pharmaceuticals and fine organic chemicals—a department of chemical industry which, while in its origins antedating the war, received its great impetus to growth in the deprivation of German products from which now, with a measure of independence attained, it desires to be and should be protected until manufacturing maturity is attained.

This body, embracing as a major organization the American Dyes Institute, represents trade organization in organic chemistry as distinguished from inorganic, as represented, for instance, in the Manufacturing Chemists' Association of the United States, and embraces interests whose raw materials are elaborated from the liquid products of the by-product coke oven. The latter-named organization embraces interests which for comparative purposes may be said to be based directly on common salt and sulphur.

This new organization is notable in that it represents the growth of enterprise in the utilization of what originally was wasted in the operation of the bee-hive coke oven, now rapidly growing obsolete. At the organization meeting held October 28-29 at Washington, D. C. Dr. Charles H. Herty, past president and former editor of *Journal of Engineering & Industrial Chemistry*, of the American Chemical Society, was elected president. The four grand divisions of the association's work are represented by four vice-presidents, viz., C. N. Turner, Newport Chemical Works, dyestuffs; S. W. Wilder, Merrimac Chemical Co., intermediates; Herman Seydell, Seydell Mfg. Co., pharmaceuticals; and B. T. Bush, Antoine Chiris Co., fine organic chemicals.

Members of the board of governors already appointed comprise in addition to the president and vice-presidents: R. S. Burdick, Abbott Laboratories, Inc.; R. C. Jeffcott, Calco Chemical Co. and president American Dyes Institute; August Merz, Heller & Merz Co.; M. R. Poucher, E. I. du Pont de Nemours Co.; P. Schleussner, Roessler & Hasslacher Chemical Co.; F. P. Summers, Noil Color & Chemical Works.

The purposes of the association as set forth in the constitution adopted are:

"To advance the science of organic chemistry by encouraging the manufacture in the United States of all kinds of organic chemicals; to co-operate with the various agencies of the Government of the United States in its efforts to develop, improve and render serviceable a complete organic chemical industry; to promote cordial relations between American concerns and individuals engaged in the production and use of organic chemicals; to afford means for the dissemination of scientific knowledge; to promote the highest scientific and business standards in relation to the industry; and generally to take such collective action as may be proper for the establishment and perpetuation of the organic chemical independence of the United States."

The offices of the Synthetic Organic Chemical Manufacturers Association are at No. 1 Madison Ave., New York, the address of the offices of the American Chemical Society.

Petroleum a Raw Material for Our Chemical Industries

By Dr. Sidney Born

Assistant General Superintendent, Refining Department, Trans-Continental Oil Co.

THE importance of petroleum as a raw material for our chemical industries has only recently been recognized. Heretofore, petroleum has been associated with gasoline, kerosene, fuel oil, lubricating oil and paraffine wax.

Stimulated by the enormous demand created during the war for organic derivatives, a new industry has been created. Not only can the same range of hydrocarbons obtainable from coal by the by-products coke oven be obtained, but many derivatives that cannot be made directly from coal by destructive distillation can be manufactured from petroleum.

Because petroleum is a liquid and readily vaporized, the destructive distillation of petroleum can be very accurately controlled as to temperature, pressure and rate of heating and by suitably modifying these conditions, a predominating amount of various series of hydrocarbons can be obtained.

Olefins, aromatics and cyclic compounds can be obtained in large amounts by using the proper conditions. These base substances are the foundation stones from which many valuable compounds are manufactured for use in the industries manufacturing explosives, dyes, rubber, photographic chemicals, paints and varnishes.

Ethylene

During the war, ethylene was used as a base substance for the manufacture of lethal gases and was obtained from alcohol by dehydration with sulphuric acid, a very expensive process. Now ethylene can be obtained in large amounts and very cheaply directly by the destructive distillation of petroleum under suitable conditions.

By modifying the conditions by which we obtain ethylene, the higher members of the olefin series may be obtained; propylene, butylene, amylene, etc. These substances are very re-active and many important organic derivatives can be manufactured from them.

That fraction of petroleum known as gas oil, is most suitable for the manufacture of ethylene and its homologues. Gas oil, usually has a Baumé gravity ranging from 32° to 36° and a boiling range of from 400° to 700° F. Various types of furnaces and many different processes have been developed and patented for the manufacture of ethylene. For a more complete discussion of this subject, the reader is referred to Bulletin 114 of the U. S. Bureau of Mines.

In general, the oil is passed through a coil or series of coils, heated to a proper temperature, ranging from 1,250° to 1,500° F., by means of a suitable furnace. Pressure or vacuum is maintained on the apparatus and the reaction products are then passed through

fractional condensers wherein the liquid constituents are separated from the gaseous ones. Depending upon the conditions employed, there will be a predominating amount of either ethylene or one of its homologues and these may be separated from each other by the usual means.

Synthetic Alcohols

An enormous demand has been created for solvents that are used in the manufacture of artificial silk, imitation leather, waterproof compounds, celluloids, photographic films and chemicals. Quite recently two of our larger oil companies have developed processes for obtaining higher alcohols directly from petroleum by subjecting the gas-oil fraction of petroleum to destructive distillation, separating the olefins from the other gases by absorption in sulphuric acid and hydrolyzing the sulphuric esters of the olefins to obtain the alcohols.

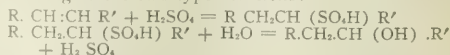


Fig. 1 General View of Cracking Plant, Showing Furnaces Used for the Destructive Distillation of Petroleum.

By this means secondary and tertiary alcohols not obtained easily from other sources, can be manufactured and the corresponding esters can be derived from these alcohols. These alcohols and esters form valuable solvents, useful in the industries.

Development of the Art

It has been known for years that the action of sulphuric acid on olefins results at least to some extent in the formation of alkyl sulphuric esters, which on hydrolysis with water yield the corresponding alcohols, according to the two type reactions:



In 1825 and 1826 Faraday and Hennel showed that ethylene is absorbed by sulphuric acid with formation of ethyl sulphuric acid, while in 1828 Hennel showed that ethyl sulphuric acid is decomposed on boiling with water to yield ethyl alcohol and sulphuric acid.

In 1855 Berthelot produced a considerable amount of alcohol from ethylene and proved it to be identical with the alcohol of fermentation. He proposed to utilize the ethylene of coal gas for the production of alcohol but obtained poor results, and concluded that this gas did not contain more than 0.2 per cent. of ethylene.

In 1863 M. Mallet pointed out a number of difficulties which would arise in the manufacture of grain alcohol from illuminating gas.

Somewhat later various other alcohols were obtained by the action of sulphuric acid on olefins, with subsequent hydrolysis with water. Thus in 1855 Berthelot obtained isopropyl alcohol from propylene. In 1870 Butlerow obtained tertiary butyl alcohol from isobutylene, and in 1877 Wischnegradsky obtained tertiary amyl alcohol from amylene.

A number of generalizations may be drawn from this early work. In the first place, in the addition of sulphuric acid to an olefin, it has been observed that the

the removal of the revenue tax from industrial alcohol permitted the production of ether from alcohol at a price below that at which it could be profitably manufactured from oil gas. From a study of the published data on this plant, I believe it could have continued to operate successfully if better chemical engineering had been used in its design and operation.

In this plant, gas oil was cracked to produce ordinary oil gas in the usual atmospheric oil gas retort. The gas obtained contained about 40 per cent. of olefins, of which half were ethylene and half heavier olefins. For the purification of the gas, all olefins heavier than ethylene were removed by scrubbing through concentrated sulphuric acid at temperatures up to 40° C., being converted to polymerization products and discarded as a dead loss besides using up large amounts of sulphuric acid.

All absorptions were carried out at atmospheric pressure, thus requiring the use of absorbers of large



Fig. 2. View of Upper Floor of Process Building, Showing Gas and Air Lines of Cracking Plant.



Fig. 3. End View of Cracking Retorts, Showing Economizer.

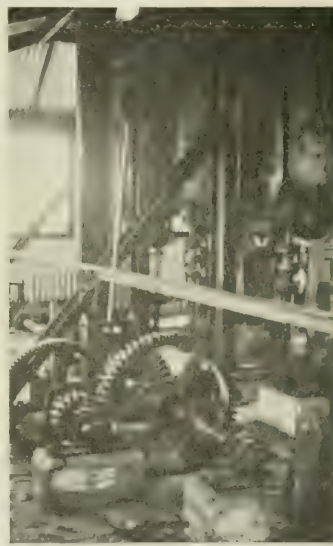


Fig. 4. View of Cracking Plant, Showing Tar Pats and Storage.

sulphuric acid radical always becomes attached to the carbon atom carrying the least number of hydrogen atoms. Consequently, ethylene is the only olefin which yields a primary alcohol by this method, all other olefins yielding secondary or tertiary alcohols.

In the second place, when we come to the olefins of larger molecular weight, the evidence of the literature is conflicting. Sulphuric acid, beside the normal reaction with olefins, also exerts a very powerful polymerizing action on the heavier olefins, converting them into di- and tri-olefins. In the case of the heavier olefins this reaction is the principal and frequently, the only reaction, unless the conditions are carefully controlled. Hence the published results of the treatment of amylene with sulphuric acid are very conflicting.

Ether from Oil Gas

In 1900 and 1901 a plant was erected at Richmond, Va., for the manufacture of ether from oil gas. This plant operated successfully until the year 1907, when

capacity, with mechanical agitation of the acid, and necessitating an unduly long time for the saturation of a charge of acid with ethylene. Further, on account of the high summer temperature at Richmond, and in view of the fact that ether was condensed only at atmospheric pressure, the plant was regularly shut down during the summer months.

The gas obtained as a by-product in cracking petroleum for gasoline, contains considerable amounts of olefins, and it was with a view of utilizing these substances that the writer undertook a series of experiments which resulted in the development of a successful process for the manufacture of alcohols from these unsaturated gases. Preliminary experiments indicated that low temperatures were necessary for the production of alcohols by absorption of the various olefins in sulphuric acid. At higher temperatures, the sulphuric acid would largely polymerize the olefins. It also was determined that dilute sulphuric acid, while fairly efficient in absorbing those olefins which were

tertiary alcohols, was only a poor absorbent for the olefins yielding secondary alcohols. Further experiments developed that the use of pressure is necessary for rapid absorption and that by the use of a series of absorbers much better results were obtained than by the use of a single absorber.

The plant developed at this time consisted of a series of four absorbers, arranged so that each one was just a little higher than the other. Fresh concentrated acid was allowed to flow into the topmost absorber and from there on it flowed through the other absorbers and came out as saturated acid liquor from the bottom absorber. The gas passed counter current to the acid, coming in at the lower absorber and passing from there on through the second, third, and fourth absorbers.

A pressure of 100 lbs. per square inch was maintained during the process. Both the gas and sulphuric acid were cooled by means of a direct expansion ammonia refrigerator so that temperatures of minus 20° C. were maintained in the two lower absorbers, the third at -5° and the fourth at 0°. Suitable heat interchanges were used to provide economical operation. By means of this counter current principle and the employment of suitable temperatures, the heavier olefins were largely absorbed in the first two absorbers and the lighter olefins in the last two absorbers. The quantity of polymerized material was reduced to a very small amount. A very important point in this development is that the higher olefins which are more sensitive to polymerization do not come in direct contact with fresh sulphuric acid but come in contact with acid already saturated with lower olefins. This dilution diminishes the violence of the reaction in the lower absorbers so that less polymerization of heavier olefins and a corresponding greater conversion to alkyl sulphuric esters which yield alcohol on hydrolysis takes place.

The saturated liquors from the bottom absorber were diluted by pouring into three volumes of water. The diluted acid was allowed to stand for three hours to allow the diolefins to separate and float on top. The acid liquor is then drawn off and charged to a lead lined steam still. The alcohols are distilled over and were separated by fractional distillation.

Other Derivatives

A great deal of work has been done on the oxidation of various hydrocarbons with and without the use of catalysts to obtain aldehydes, ketones and acids. In this way many substances have been obtained which cannot be obtained easily from other sources. By the chlorination of various hydrocarbons derived from petroleum valuable substances like chloroform, dichlorethylene and many other chlorine derivatives can be obtained.

Artificial Rubber

The main drawback to the synthesis of artificial rubber has always been a cheap source of butadiene. Petroleum offers a cheap and easily handled raw material for the preparation of butadiene and other diolefins and considerable work has been done on the preparation of these substances, directly from petroleum by destructive distillation with the use of certain catalysts.

These diolefins can be readily transformed into artificial rubber, which compares favorably in all respects with natural rubber. The commercial synthesis of rubber is not only possible but offers greater possibilities than the synthesis of any other natural product

Dye Stuffs and Pharmaceuticals

Toluene, benzene, naphthalene and other basic substances used in the manufacture of dyestuffs and pharmaceuticals can be obtained from petroleum by destructive distillation, and while some of the present methods of manufacture will not compete with similar substances obtained from coal, it will be only a question of time when these methods are so perfected that the competition from this source will be a serious one.

The writer desires to acknowledge the valuable assistance of Dr. Robert M. Isham in the work outlined in this paper.

Enlistment in the Bureau of Standards

The United States Civil Service Commission, Washington, D. C., announces open competitive examinations for the positions of laboratory assistant, junior grade (\$1,000 a year), senior aid (\$900 a year), junior aid (\$720-\$840 a year), and laboratory apprentice (\$540 a year) in the Bureau of Standards, Washington, D. C.

These examinations cover positions included in the usual entrance grades of the scientific and technical staff of the Bureau of Standards and preference in appointment will be given to those who state in their applications that they intend pursuing a scientific career or desire to complete a college education in pure sciences, in some branch of physics, engineering, chemistry, or other branch of the bureau's work.

The Bureau of Standards covers a wide field of work in physics, chemistry, engineering, and industrial technology, including research and standardization, and offers valuable experience to those preparing for these professions. Experience in the Bureau is considered an admirable training for scientific work, and its close connection with the industries makes it particularly valuable as a training in industrial research. The Bureau's facilities make it perhaps the best equipped physical laboratory in the world. Its location is pleasant, about two miles from the built-up portion of Washington, on high ground in the open country.

Junior assistants are afforded the opportunity of continuing their college work at local universities. The university courses are largely arranged to suit the convenience of persons in the Government service, and classes in most subjects are given in the late afternoon or evening. Arrangements are made at the Bureau so that employees taking courses at the universities can be excused from their work early enough to attend these classes. The Bureau has a scientific library of 18,000 volumes and the free use of the other scientific collections in Washington.

The educational opportunities are excellent in view of the weekly meetings of the bureau staff, the journal meetings of its Physics Club, and cooperative study courses in physics, mathematics, etc., conducted by members of the staff and others, and special lectures by visiting specialists and the meetings of National Societies. These advanced courses at the bureau are accepted by several universities as credits toward a higher degree.

Investigation of the holdings of the Texas Co. in Hoskins Mound, Prazoria County, Texas, has reached a point where several hundred acres have been proven to contain a commercial body of sulphur, which ranks in size with the largest proven bodies. Wells have been drilled to 1,100-1,200 feet and the next step, which would be the working of the properties and probably the erection of a plant, is awaiting complete engineering reports.

The Mellon Institute of Industrial Research

Origin, Service and Administration of an Institution Dedicated to the Cooperation of Science and Industry.

THE appointment by the Board of Trustees of the University of Pittsburgh of Edward Ray Weidlein as Director of the Mellon Institute of Industrial Research directs attention to the character and service to industry, and through it to the people, of this remarkable institution.

Mr. Weidlein's appointment as successor to Dr. Raymond F. Bacon, who has engaged in consulting chemical practice in New York, represents a series of promotions which can be said to have begun as a student at the University of Kansas, under Dr. Robert Kennedy Duncan, who was the parent of the system of practical cooperation between science and industry exemplified by Mellon Institute and who served as its first director until his death in 1914. Born in 1887 at Augusta, Kansas; graduated, B.A., 1909—M.A., 1910, from the University of Kansas; from 1912 to 1916 Senior Fellow at Mellon Institute; assistant and associate director in 1916; acting director in 1918 during the absence in the army of Dr. Bacon, Mr. Weidlein brings to his new responsibilities a keen sense of the function of the Institute and of the needs of industry, born of close contact with the formulator of the Institute's service and of experience with its performance.

Industrial Fellowship System of Mellon Institute

The Industrial Fellowship System now in successful operation in the Mellon Institute of Industrial Research of the University of Pittsburgh was formulated by the late Dr. Robert Kennedy Duncan in 1906, being first presented to the American public in an article published in *The North American Review*, May, 1907, and shortly afterwards in Dr. Duncan's demo-chemical classic "The Chemistry of Commerce." The Industrial Fellowship System was placed primarily in experimental operation at the University of Kansas in January, 1907, and on March 1, 1911, it was inaugurated at the University of Pittsburgh.

In March, 1913, Messrs. Andrew William Mellon, now Secretary of the Treasury, and Richard Beatty Mellon, a prominent banker and industrialist of Pittsburgh, established it on a permanent basis. In 1914, the Mellon Institute of Industrial Research, the home of this system of practical cooperation between science and industry, was erected on the campus of the University of Pittsburgh; this building and the permanent equipment of the Institute make it the most complete and most modern industrial experiment station in the United States.

The Mellon Institute is an integral part of the University of Pittsburgh and is operated in the closest sympathetic accord with that institution. The Adminis-



EDWARD RAY WEIDLEIN
Director Mellon Institute of Industrial Research

trative Staff of the Institute reports directly to a committee of the Board of Trustees of the University of Pittsburgh which is constituted of Dr. John G. Bowman, Chancellor of the University, and Messrs. Andrew William Mellon and Richard Beatty Mellon.

Description of the Industrial Fellowship System

According to the system of research in operation in this institution, an industrialist, a company, or an association of manufacturers having a problem or group of problems requiring investigation may become the donor of an Industrial Fellowship by contributing to the Mellon Institute a definite amount of money, for a period of not less than one year. This foundation sum must be adequate for the purchase of all necessary special apparatus or other equipment, as well as to furnish the annual stipend of the research man or men selected to work on the particular problem, the solution of which is of interest to the donor.

Each Industrial Fellow is selected carefully by the Institute, and the work to be done is committed to this competent man who is not otherwise preoccupied. The Institute houses the investigatory work, furnishes it with the use of its permanent equipment, affords library and consultative facilities, gives careful direction to the progress of the research, and provides an atmosphere which is conducive to productive inquiry. All results obtained during the course of the Industrial Fellowship belong exclusively to the donor.

The main object of the Institute is to supply for well-trained investigators every incentive and the most favorable opportunities for fruitful research in the physical sciences and technology, and to make science subserve the practical needs of industry. It is not, in any sense of the word, of a commercial nature, being entirely independent and deriving no financial profit from any investigation conducted under its auspices. This system constitutes a tried method of combatting pseudo-research in industry, for the cost factor is reduced to a minimum; by it the Mellon Institute, which is national in its activities, has been able to demonstrate to American manufacturers that industrial research, properly carried out, is profitable to them.

Tributes to Mellon Institute

Dr. R. W. Raymond once said, "the genius and wisdom of your beloved and lamented Dr. Duncan seem to me to have found a wonderful solution for a difficult problem in this scheme of Industrial Fellowships." Dr. James McKeen Cattell has stated that "we need a Mellon Institute for each science and in every city." Sir William Ramsay referred to the Institute's system

in the following words: "The scheme of Industrial Fellowships is an admirable one, which could be applied in England with great advantage." Mr. E. G. Scott, the eminent chemical engineer of London, voiced a similar sentiment when he stated that "it seems to me that some such system is needed in England." Dr. C. A. Keane, Principal of the Sir John Cass Technical Institute, of London, has also endorsed the system; in an address delivered in 1917, he stated that "the system of Industrial Fellowship scheme has shown one way in which the universities could be utilized."

The system also has received the most cordial endorsement and the highest recognition of prominent American chemists. Dr. Arthur D. Little has stated that "research on a great scale is of course wholly beyond the means of the average manufacturer, but it is also beyond his requirements. These are well served by such an agency as the Mellon Institute at Pittsburgh." Professor Marston Taylor Bogert has expressed the following opinion of the economic importance of the Institute and its system:

"Our own country is beginning to awaken to the fact that civilization unarmied by science is at a terrible disadvantage in the event of a struggle for existence, and that this arming cannot be done at short notice. The result is a loud and urgent call upon the universities, colleges and technical schools of the land for help. Conspicuous among those answering this call most effectively are the University of Pittsburgh and its Mellon Institute.

"Conducting an energetic campaign for the education of the community to a better appreciation of science, pointing out to the manufacturers wherein the chemist can aid them, and winning their support for chemical research, prosecuting skilful investigations directed to the immediate public needs, and turning out highly-trained scientists, this university has already made an enviable record of service, and has placed under a lasting debt of gratitude not only the city of Pittsburgh, the chemical profession and the nation, but the entire world of humanity as well; for its activities minister in the highest degree to the progress of civilization, and its achievements ultimately become the property of all mankind."

Mellon Institute has never aspired to largeness in size. The policy is to devote its funds to improving the quality of its work rather than to increasing the quantity thereof. Indeed, since the number of Industrial Fellowships in operation is limited by the number of men on the Institute's Administrative Staff and by the Institute's housing space, it has been required during the past year to decline temporarily several technologic investigations of importance, offered by some of the strongest corporations in the country, owing to the fact that the Institute is at present filled to capacity.

The following table presents the number of Industrial Fellowships which have been founded in the Institute from March of each year, 1911 to 1921; the number of Industrial Fellows (research chemists and engineers) who have been employed thereon; and the total amounts of money contributed for their maintenance by the Industrial Fellowship donors (industrialists and associations of manufacturers):

March to March	Number of Fellowships	Number of Fellows	Total Foundation Sums
1911-1912.....	11	24	\$39,700
1912-1913.....	16	30	54,300
1913-1914.....	21	37	78,400
1914-1915.....	21	32	61,200
1915-1916.....	36	63	126,800
1916-1917.....	42	65	149,100
1917-1918.....	42	64	172,000
1918-1919.....	47	77	238,245
1919-1920.....	47	83	293,680
1920-1921.....	48	83	320,848

There are now 48 Industrial Fellowships, and several additional Fellowships will begin operation just as soon as the necessary facilities can be provided. It may be

noted here that there has been in the last few years a real scarcity of men of demonstrated research ability, and the Mellon Institute adheres to the policy of starting new work only as qualified scientific investigators are available.

The total amount of money contributed by industrial firms to the Institute for the ten years ending March 1, 1921, was \$1,534,273. During the ten years, the Institute itself expended approximately \$470,000 in taking care of overhead expenses—salaries of members of the permanent staff and office force, maintenance of the building, purchase of books and apparatus, etc.—in connection with the operation of the Industrial Fellowships. Besides this amount, the building and permanent equipment of the Institute represent an investment of about \$350,000. In addition to the above sums, an amount of money now running into several million dollars has been spent by the industries in developing into large scale manufacture various processes worked out at the Institute.

Types of Industrial Fellowships

An inquiry which frequently comes to the Institute is, "What is the most important research now in progress?" The investigational activities of the Institute are now so varied that any item of progress of special interest to one group of individuals may be paralleled by other items of equal interest severally to other groups. The question cannot, therefore, be answered except with the conditional stipulation that, since opinions are at difference, the inquirer is permitted to ascertain for himself, and with the supplementary proviso that in so doing he is incapable of forming an adequate estimate of the aggregate of these investigations. The list of the 48 Industrial Fellowships in operation should be regarded as indicating the diversity of the Institute's work, rather than as emphasizing any part of it.

The Industrial Fellowships are of two general types, viz., Industrial and Multiple. An Individual Fellowship utilizes the services of one research man (with assistants when necessary), directly responsible to the Administration, while a Multiple Fellowship has the intensive work of one or more investigators under the supervision of a Senior Fellow, who, in turn, is under the direction of the Administrative Staff.

There are now 34 Individual and 14 Multiple Fellowships. Of these two types, the following have been founded by associations:

No.	Names	Company- Members in Associations
239	Stove	14
256	Fiber	20
260	Magnesia Insulation	4
263	Insecticides	8
269	Cleaning	11
270	Metal Ware	17
271	Laundry	1850
272	Refractories	99
275	Magnesia Products	4

Individual Fellowships established by associations of manufacturers not only enable the Institute to be of direct service to groups of industrial concerns instead of to individual companies, but their successful operation also gives rise to more stable relations of cooperation among the company-members of these associations by the induction of the reciprocal exchange of experience and research results. The Institute acts as a clearing house of information for donating associations, and gives all the assistance and advice in its power to the company-members.

Two of the Multiple Fellowships now in operation have been effectively at work since the foundation of the Institute, while most of the Individual Fellowships have been promoted continuously for the past 3 years. The larger Multiple Fellowships are so well established and so distinctive in their fields of inquiry that they are not uncommonly regarded as independent organizations, and indeed several of them have been mistaken for the Mellon Institute as a whole. These misapprehensions are the result of the existing favorable relations of the Fellowships to the Institute, which, when the donors so desire, secure to them a degree of autonomy which could hardly be surpassed under other conditions.

The liberties of action, thus designedly and freely conceded wherever possible, have done much to insure the constantly successful conduct of the Industrial Fellowships. It is of interest to mention here that the incumbents of the larger Industrial Fellowships are recognized generally as authorities in the specific branches of technology in which they are carrying out investigations.

Publications of the Institute

The objects of every well-founded, properly operated research institution are three in number, viz.: (1) the creation of knowledge; (2) the dissemination of knowledge and the direct technical application of such knowledge to its outside environment; and (3) the adequate instruction of its investigatory staff in research methodology. In the long run, therefore, an industrial research establishment must be known by the successful commercial processes which it has inaugurated and by the published accounts of the inquiries conducted under its auspices. It is of prime importance to the progress of science and technology to transmit as soon as possi-

ble after their completion trustworthy records of methods, theories, achievements, and even of errors and failures. In illustration of this function of the Institute, it seems fitting to present here a list of the contributions from the Institute during the past nine years.

CONTRIBUTIONS FROM THE MELLON INSTITUTE

Year	Books Published During Year	Reports of Researches Published During Year	Other Scientific Papers Published During Year	United States Patents Issued During Year
1912.....	1	13	3	1
1913.....	..	20	10	1
1914.....	..	17	3	7
1915.....	..	10	11	22
1916.....	3	18	4	20
1917.....	..	14	5	35
1918.....	..	34	8	27
1919.....	..	23	17	37
1920.....	2	36	48	17

Since the resignation of Dr. Raymond F. Bacon as Director, the Administrative Staff of the Mellon Institute is constituted as follows: Edward R. Weidlein, Director; E. Ward Tillotson, Jr., Assistant Director; William A. Hamor, Assistant Director; Harry S. Coleman, Assistant Director; H. A. Phillips, Treasurer.

In addition to attending to the management of the Institute, the Administrative Staff prepares schemes of research work, selects the Industrial Fellows, determines the amount of their remuneration, and supervises their investigations; but its members do not, as a rule, conduct industrial research themselves. It is an executive body which is supported by the income of the institution.

How Heat Losses in Chemical Plants May Be Reduced

By John Primrose

Vice-President, Power Specialty Co.

FUEL has become an important item of the cost of manufacture in all industries. The chemical industry not being an exception, it is worth while to investigate how heat produced from fuel is in the first place generated, and afterward how it is utilized; because it is hoped such an investigation will lead to the discovery and elimination of avoidable wastes and a reduced fuel bill.

In a great many plants more fuel is consumed for the generation of steam used for power and process work than for any other purpose. Modern engineering practice has recognized the importance of good combustion, and means are now available for more completely burning the fuel before attempting to recover any of the heat produced by combustion. It used to be customary to set boilers so close to the fire that insufficient furnace volume was provided, resulting in incomplete combustion; and so much of the fuel was wasted at the start.

Incomplete combustion produces smoke which is a nuisance as well as a money loss; consequently furnace construction should be studied carefully by competent engineers and adapted to the kind of fuel used. After the fuel is properly burned the next consideration is to absorb the heat produced. The boiler heating surface should be proportioned and arranged to cool the gases from the furnace to not more than 500° F., if natural draft is used. If induced draft and econ-

omizers are used the flue gas temperature can be reduced to 300° F. Means should be provided for easily and thoroughly cleaning the heating surface inside and out, and the heating surface kept clean from soot and scale. This is important and frequently receives too little consideration.*

Feed Water

The feed water supplied to the boiler should be as hot as possible for the purpose of economizing in fuel and of protecting the boiler against strains produced by feeding cold water. Water can be heated to 210° F. in feed-water heaters by exhaust steam from feed pumps or other equipment using steam; but, as each pound of exhaust steam has, roughly, one thousand heat units available, and it is only possible to heat the feed water to 210° without increasing the back pressure on the exhaust, only about 14 per cent. in weight of the steam generated can be used in this way if the temperature of the cold feed averages 70°. If the exhaust steam exceeds 14 per cent. of the steam generated in weight and any considerable portion of live steam is used in turbines or engines, then condensers should be considered so as to obtain more power per pound of steam generated before it is abandoned.

An exhaust steam feed-water heater can be counted on to increase the feed temperature 140 degrees, or a total temperature of 210 degrees, from 70° F. cold water. This will produce a saving of, roughly, 14 per

*Presented at Power Plant Symposium, Chemical Exposition, September 16, 1921.

cent. in fuel. The feed at 210° then can be passed through an economizer or flue-gas heater and the temperature of the feed increased from 210 to 320°, or higher if the steam pressure carried permits.

This further increase in feed water temperature of 110 degrees will produce a further fuel saving of 11 per cent., so that by properly heating the feed a fuel saving of 25 per cent. is possible over feeding cold water. To accomplish this an induced draft equipment is necessary, because the temperature of the flue gases, after passing through the economizer, will be not more than 300° F., which is too low a temperature to produce sufficient natural draft by a chimney. This combination of feed-water heater, using exhaust steam and economizer, would make it possible to recover in the steam close to 80 per cent. of the heat in the fuel burned in the furnace. These are figures which it can reasonably be expected to approach in everyday practice with ordinary care in operation.

Insulation

Having produced steam economically, the next step is to utilize it with the least possible loss in heat. The boiler, all steam and feed lines, as well as steam-using equipment, should be thoroughly insulated to cut the radiation loss to a minimum. This will prevent an uncomfortably high temperature in the workrooms and effect a saving in fuel as well. The boiler can only supply saturated steam containing a percentage of entrained moisture, and the steam in this condition parts with its heat much more readily than when heated above the temperature at which it is generated in the boiler, or, as it is called, superheated.

Superheated Steam

Superheated steam is a dry gas and absorbs moisture; whereas saturated steam as delivered by the boiler is in a condition of fog, and all surfaces that it comes in contact with are wet. Steam lines carrying superheated steam can be smaller in size, as the friction loss is less and the radiation of heat will be smaller than with saturated steam.

The steam required to produce a given power in turbines, engines and pumps is so much less when the steam is superheated that it pays to expend the fuel necessary to superheat the steam, and a net fuel saving up to 15-20 per cent. may be realized by superheating, depending upon the kind of equipment using steam. Superheaters can usually be located as a part of the boiler in the setting, or they can be set independently of the boiler. In either case they require little attention and the cost of upkeep is small.

Steam used in heating coils or steam jackets for heating processes may be moderately superheated, but the requirements should be carefully studied in each case. The effectiveness of the heating surface will be reduced if supplied with superheated steam, unless it is rapidly circulated, because superheated steam parts with its heat so reluctantly. Where steam is condensed in heating coils and the resulting water trapped off, superheat is of no value and may even be a detriment.

It is possible to obtain only temperatures somewhat less than the temperature of the saturated steam when the steam is condensed. When higher temperatures are required, superheated steam may be used, but it must be circulated at a high rate and leave the heating surface superheated at a somewhat higher temperature than the process requires. Steam can be superheated to 1,200°, and the heat available in a process requiring 500°, which is above the temperature possible by condensing the steam, would be the heat represented by the cooling of the superheated steam from 1,200

to 500° F., or, roughly, 325 heat units per pound.

Three times this amount of heat is liberated by condensing saturated steam, but it is at too low a temperature range to be available. The superheated steam leaving at 550° still has about 1,100 heat units per pound remaining, and unless this steam can be used in other parts of the plant the heat rejected is so much more than the heat used that the process is uneconomical. There are many places, however, where the heating process can be used as a step-down heat transformer, reducing the steam temperature so as to be suitable for use in engines or pumps, or other heating processes. In such cases highly superheated steam is very economical and a most satisfactory medium for supplying heat, and has the additional advantage of temperature control, which is important in heating processes where the material to be heated may be damaged or destroyed by overheating.

Saturated Steam

Of all methods of supplying heat in process work probably the most economical is heating by saturated steam where the steam is condensed and the resulting hot water is returned to the boiler. This is limited to processes that do not require a temperature higher than is available with saturated steam, say, 300° F. Above this temperature, up to 600° F. or higher, superheated steam may be used, and if the steam can be used in turbines or pumps, etc., after it has served its purpose as a heating medium and the exhaust is used in heating feed water, the economy is almost as good as with saturated steam.

Fluid Heat Transference

Rather than waste superheated steam after all the heat available has been extracted in heating, it is more economical to employ some other heat-carrying medium, such as oil or water. The oil or water is heated well above the temperature required in the process, circulated through the jacket or coil where it is cooled (by giving up heat to the material) to a little above the temperature required, and passed back to the heater by means of a pump in a closed circuit.

To prevent the water vaporizing and forming steam, it is necessary to carry high pressures—water at 600° must be well above 1,600 lb. pressure—and this is objectionable, often impracticable. Some oils, on the other hand, can be heated to 600° at low pressure without vaporizing or carbonizing, and a closed system circulating hot oil at 600° is now common practice for processes requiring temperatures up to 500° F. In such a system it is important to exclude all air, because oil at this temperature combines easily with air and burns rapidly. It is also important to use care in heating the oil, which must not be overheated, and the design and construction of the heater should be handled by experts to insure success.

In many cases it has been found practicable to supply heat direct from a furnace. A more complete knowledge of combustion has made it possible to design furnaces having a uniform temperature and controllable as to intensity. By combining proper furnace design with a proper arrangement of heating surface, it has lately been found possible to supply heat direct from a furnace in processes where the material to be heated is so sensitive to heat that direct heating had been abandoned.

Shell Torpedo Co., Gorman, Texas, Frank Kirk, president, has been organized to manufacture nitroglycerine and is erecting a plant near Gorman with a daily capacity of 1,200 quarts of nitro-glycerine.

The Procedure of the Synthesis of Ammonia

The Process and Apparatus for the Synthetic Production of Ammonia from Nitrogen and Hydrogen

By Carl Bosch, Ph.D.

Chief Chemical Engineer, Badische Aniline und Soda Fabrik, Ludwigshafen am-Rhein

THE importance of the synthetic production of ammonia from nitrogen of the air and hydrogen of water and the part that the process will play in the economy of nations, have been emphasized by the disaster at Oppau, described in the October *CHEMICAL AGE* by Theodore M. Sill, ex-Major, Chemical Warfare Service, U. S. A. Here follows a description of the process and equipment there used, which will serve to indicate the magnitude and complexity of the chemical engineering problems whose solution must be accepted as a tribute to the German technical genius.*

Separation of two gases, their purification, compression and combination under suitable conditions of temperature and pressure and presence of a catalytic agent, while apparently a simpler procedure than the manufacturing processes devised by Ernest and Alfred Solvay for the production of caustic soda far surpass them in the stupendous energy and requisite equipment for effecting a much simpler reaction; and more particularly so when we compare the processes of the chemical engineer with the leisurely synthesis of the legume.

Preparation of Hydrogen

The hydrogen and nitrogen which are employed as initial products in the synthetic manufacture of ammonia can be prepared in a diversity of ways. Thus, for instance, the hydrogen can be prepared by the electrolysis of a suitable solution, for example, during the production of chlorine and caustic soda by electrolysis of sodium chloride solution, in which case hydrogen is evolved as a by-product at the cathode.

Another group of methods is based upon the removal of oxygen from water by means of carbon. The first of these methods of preparing hydrogen on a large scale may consist in fractionating water-gas by cooling the water-gas until it partly liquefies and then allowing the liquid to distil according to the method of Linde.

Furthermore, the known process may be used in which two such circuits are combined. In the first circuit air is liquefied and fractionally separated, giving rise to nitrogen and oxygen while the circuit is so arranged that the cold produced is transferred to the second circuit, in which the water-gas is liquefied and is then fractionally separated, giving rise, on the one hand, to hydrogen and, on the other hand, to carbon monoxide.

Another of the methods of producing hydrogen from a mixture of hydrogen and carbon monoxide, such, for instance, as water-gas, consists in mixing the water-gas with steam and passing the mixture over a contact material, as iron, at a temperature of from 400° to 600° C., when the carbon monoxide is converted into carbon dioxide, while a corresponding quantity of steam is reduced to hydrogen according to the equation $\text{CO} + \text{H}_2\text{O} = \text{CO}_2 + \text{H}_2$. It is to be understood that the iron may be present, during the re-

action, in the state of ferric oxide or ferrous oxide or compounds or mixtures of both. The carbon dioxide can be separated from the hydrogen in any suitable manner, or, in particular, in the manner to be described.

Apparatus for obtaining hydrogen from water-gas may be constructed as illustrated in Fig. 1. Here water-gas is passed through the coil Q, where it is preheated and steam is admitted through the pipe X, the mixture passing through the center tube of a double spiral regenerator R; then through the outer tube of the regenerator S through the contact mass T, where the water vapor and carbon monoxide react forming carbon dioxide and hydrogen; the resulting gases then pass through the regenerators S and R and then through the coil V, where any excess of steam is condensed.

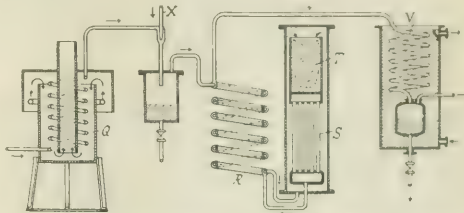


Fig. 1. Diagram of Apparatus for the Production of Hydrogen from Water Gas.

According to a third method of carrying out this process, hydrogen can be prepared for the synthetic production of ammonia by alternately oxidizing and reducing a suitable metal, such as iron. Thus steam can be passed over iron at the requisite temperature so that iron oxide is produced and hydrogen obtained, and then, when the iron is oxidized to a sufficient degree, it is reduced by generator-gas or an equivalent thereof, as water-gas, or a suitable naturally occurring gas can be employed. The various gases are preferably heated to the necessary degree before being passed to the vessel containing the iron or iron oxide, as the case may be, so that the latter is maintained at the temperature suitable for the reaction.

Purification of Hydrogen

The hydrogen prepared according to several of the above methods contains impurities, in particular carbon monoxide and carbon dioxide, which it is desirable to remove before employing the hydrogen for the production of ammonia. Any suitable method of removing these impurities may be employed, for instance any considerable quantity of carbon monoxide can be converted into carbon dioxide in the manner above described, while smaller quantities of carbon monoxide can be removed by passing the gases over caustic soda at a temperature of, say, 200° C. It is often advantageous to employ pressure up to two hundred atmospheres although higher pressures can be employed, if desired.

Any larger quantities of carbon dioxide can be removed by treating the gases with water under considerable pressure, in which case the solubility of the carbon dioxide in water is greatly increased and small

*Adapted from U. S. Letters Patent No. 1,286,760, issued August 9, 1921, to Dr. Carl Bosch, and assigned by mesne assignments to Chemical Foundation, Inc. Methods for the synthetic production of ammonia by passing a mixture of hydrogen and nitrogen over a catalytic agent by what is commonly called the Haber process are the subject of U. S. Letters Patent Nos. 1,006,206, 512,680, 599,100, 599,101, 670,433, 670,444, 670,445, 670,446, 681,013, 681,014 and 675,618.

quantities of water remove large quantities of carbon dioxide. Smaller traces of carbon dioxide can be removed by passing the gases over potassium carbonate, which is thereby converted into potassium bicarbonate according to the equation: $K_2CO_3 + CO_2 + H_2O = 2KHCO_3$.

The minute traces of carbon dioxide which may remain after this treatment can then be removed by passing the gases over caustic soda.

Preparation of Nitrogen

The nitrogen which is employed for the synthetic production of ammonia also can be prepared in various ways. For instance, it can be prepared by fractionating liquefied air according to Linde's method and this fractionation may, as already described, be carried out in conjunction with the fractionation of water-gas for the production of hydrogen.

A second method of preparing nitrogen consists in burning hydrogen in the presence of air. For the purpose of producing synthetic ammonia it is very advantageous to use a considerable excess of hydrogen, so that the resulting gases contain, in addition to water vapor, nitrogen and hydrogen in the proportion in which they are required for the synthetic production of ammonia. The reaction can be represented by the following equation:



It is then only necessary to remove the water from the gases, which can be done, for the greater part, by cooling until the water is condensed, while further smaller quantities can be removed by various reagents, e. g., calcium chloride, quicklime, phosphorous pentoxide and the like, whereupon the remaining mixture of hydrogen and nitrogen is ready for use and can be passed into the system in which the ammonia is being produced.

Another method of preparing nitrogen consists in burning generator gas with air, whereupon a mixture of nitrogen and carbon dioxide is obtained. The carbon dioxide can be removed in the manner described, or in any other convenient way, and the nitrogen can be employed in the production of ammonia.

When hydrogen is burned in the presence of air in the manner described above, the nitrogen and hydrogen can be obtained ready mixed in the proportion desired for the production of ammonia. When the nitrogen and hydrogen are obtained separately, they are generally preferably mixed in the suction tube leading to the compressor.

Purification

The gases also must undergo purification in order to remove any ingredients which might prove injurious either to the contact material or for other reason, are undesirable. Thus, for instance, the water-gas, or the generator gas, should be washed with water and also passed through a dry purifier containing iron for the purpose of removing any sulphur or compounds containing sulphur.

Various steps of purification can be carried out either while the gases are separate or mixed and while they are at ordinary pressure or while under compression, as is most convenient. In any case it is desirable to pass the gases after compression, but before being introduced into the actual circuit in which the manufacture and absorption of the ammonia are taking place, over material as far as possible identical with the contact material and also maintained at about the same temperature as is employed for the said contact material.

This has the effect of removing from the gases any matter which would otherwise injure the contact material. Thus, if iron is employed as the contact material, the compressed gases, before entering the actual manufacturing circuit, should be passed through an auxiliary furnace containing iron material similar to that used as the contact, whereupon any injurious traces of sulphur and oxygen are retained, injurious carbon monoxide is converted into indifferent methane and the gases generally are freed from ingredients which might injure the actual iron contact upon which the manufacture of ammonia is dependent.

Compression of Gases

Compression of the gases to the desired degree, i. e., to from 150 to 200 atmospheres, is preferably brought about with successive compressions, and the heat generated during each compression can be removed, wholly or in part, before subjecting the gases to the next step.

In order to prevent the system attaining too high a pressure and to prevent any great variation in the pressure, a battery of gas cylinders capable of withstanding a high pressure and acting as a reservoir for the gases, is inserted into the system between the compressor and the purifier through which the gases pass before they enter the actual manufacturing circuit. The battery of gas cylinders is also of use when the compressors cease to work for a short time, as the gas contained in the battery is then able to supply the circuit with a fresh mixture of gases during the interval. The cylinders are consequently generally kept at a somewhat higher pressure than that obtaining in the circuit.

Heat Regeneration and Chemical Reaction

The gases, after being compressed to the desired degree and having passed through the purifier, enter the actual circuit and pass to the actual contact furnace through one or more heat regenerators, in which they take heat from the gases leaving the contact furnace. It is preferred to pass the cold gases first of all through the outer tube of two tubes which are arranged concentrically in a spiral, the whole double spiral being carefully insulated so as to conserve the heat as far as possible.

After the gases leave this first regenerator, they pass through a second, consisting of a number of narrow tubes situated inside one broader tube. This second regenerator is also carefully insulated. After the gases leave the second regenerator they pass through a third regenerator which is directly attached to the end of the contact tube or furnace and which also consists of a number of narrow tubes contained in one large tube. Here the gases traveling toward the contact mass are enabled to extract heat from the very hot gases just leaving the contact furnace and they then pass along outside the said furnace to the other end thereof and then reverse their direction of flow and pass into and through the contact furnace, where a certain proportion of them is converted into ammonia.

These gases containing ammonia then pass through the narrow tubes of the third regenerator, thence toward the narrow tubes of the second and through them, and finally through the inner spiral tube of the first. They are then drawn by a circulating pump and passed to apparatus where they are treated in any suitable manner to remove the ammonia from them, and thence pass anew through the regenerators and contact mass.

It is preferred to employ the different regenerators

along toward the apparatus for extracting the ammonia from the gases.

In order to ascertain whether the gases are passing correctly through each of the contact furnaces, use can be made of the well known appliance in which the pressure of the gases on each side of a constriction in the tube supplying the gases to each of the furnaces is measured, and if desired, automatically registered. Any increase of velocity of the gases in any one of the said tubes immediately leads to alteration in the difference in pressure on each side of the said constriction in the tube and can at once be detected and remedied.

As a rule, the gases containing ammonia pass to a circulating pump, of which, if desired, several can be employed; it is desirable that these circulating pumps should contain no parts of copper with which the gases could come into contact. The above arrangement is also of value, since any oil which may be taken up by the gases while passing through the pump cylinders is removed by the absorbing liquid and is not allowed to pass to the contact mass, which it might spoil.

Separation of Ammonia

After leaving the circulating pump, the gases are cooled and contain, say, four per cent. by volume of ammonia. In order to extract this ammonia from the gases, resort may be had to cooling, so that the ammonia is obtained in liquid form. At a temperature of -20° C. about two per cent. of ammonia, that is, half of it, can be removed, while the other two per cent. remains in the gases; while at a temperature of -80° C. only 0.5 per cent. remains in the gases and 3.5 per cent. is obtained in the liquid form.

The liquid ammonia thus obtained contains nitrogen and hydrogen in solution, and it is consequently necessary to fractionate the mixture in order to obtain the ammonia in a marketable form. If desired, the ammonia can be dissolved in water, and for this purpose can be passed through four wash-bottles in series on the countercurrent principle. Since the absorption is carried out while the gases are still under high pressure, say, 150 atmospheres, the water has to be pumped into the first wash-bottle and the absorbing liquid is also pumped from each bottle to the following, and moreover is subjected to a cooling process between each bottle. The wash-bottles preferably can be made of steel. When the liquid in the last wash-bottle has attained the desired strength it can be drawn off by means of a suitable tap.

Although it is possible, in carrying out the absorption under such high pressure, to obtain a very concentrated solution of ammonia in water, it is preferred to carry on the absorption only to that point at which an ammonia solution is obtained which, under ordinary pressure, is stable and does not evolve any large quantity of ammonia.

Another arrangement which is eminently suitable for absorbing the ammonia from the gases by means of water, consists of three coiled tubes situated one above the other so that water which is pumped under pressure into the top coil runs through this and then at its own weight runs down to the middle coil and after passing through this, runs to the lowest coil and from this to a suitable receptacle, whence it can be drawn off in any suitable manner.

In the meantime the gases containing ammonia are passed into the upper end of the lowest coil and through this in the same direction as the absorbing

liquid. From the lower end of the lowest absorbing coil the gas leaves the absorbing liquid and is led to the upper end of the middle coil, so that in this coil also the gases and the absorbing liquid pass in the same direction through the coil, that is, from top to bottom. The gases leaving the lower end of the middle coil then pass to the upper end of the top coil and, as is the case in the other coils, the gases and the absorbing liquid pass through the coil in the same direction, that is, from top to bottom.

Thus in the top coil the gases which are poorest in ammonia, since they have twice been subjected to the action of an absorbing liquid, are treated with fresh water and in this way a maximum of ammonia is extracted from the gases. Each of the absorbing coils should preferably be immersed in a water-bath or subjected to other means of cooling, so as to remove the heat caused by the absorption of the ammonia. Apparatus illustrating this method of absorbing ammonia is shown in Fig. 3.

The absorbing liquid enters through the pipe 13 into the first absorbing coil 14, while the gas leaving the second absorbing coil 15 passes through the pipe 16 which also leads to the coil 14. The absorbing liquid and the residual gas leaving the coil 14 pass through the stripper 17, the gas being led away through the pipe 18, while the absorbing liquid enters the coil 15 after having passed through a siphon 19; then, after having passed through coil 15, it passes to a third coil 20.

The concentrated ammonia solution is finally collected in a vessel 21, from which it can be led off as desired. The gases containing ammonia enter the absorbing system through the pipe 22 and take the path indicated by the arrows, passing in succession through the coils 20, 15 and 14, in each traveling through the said coils from top to bottom, that is, in the same direction as the absorbing liquid.

After the gases have been treated to remove the ammonia to the extent considered desirable, taking into consideration the difficulty of extracting the last traces, they are passed back again to the furnace, but on the way thither are passed through large strippers so that the velocity of the gases is greatly reduced and opportunity is given the water, whether as such or as vapor, to separate out from the gases. It is to be understood that the gases are maintained under pressure during the whole of the operation and kept in motion in the circuit by means of circulating pumps; that portion of the gases, which combines to form ammonia, and is then removed from the system, being replaced by a fresh quantity of mixed hydrogen and nitrogen pumped into the system as hereinbefore described.

Description of Procedure and Equipment

Apparatus for carrying out the manufacture of ammonia according to my invention* here described is diagrammatically illustrated in Fig. 4. The mixture of hydrogen and nitrogen is raised by the compressor 23 to the necessary pressure, it being understood that although only one cylinder is shown, the compression can be carried out, if desired, in several steps. 24 represents a battery of steel cylinders which act as a reservoir for the compressed gases. 25 is a cylinder containing material similar to the catalytic agent employed and maintained under practically similar conditions to the actual catalytic agent. This said cylinder

* Patent 1,286,760. Issued August 5, 1921, and assigned by inventors to Chemical Foundation, Inc.



Comparison of the above photograph of the Oppau Synthetic Ammonia plant of the Badische Anilin und Soda-Fabrik near Ludwigshafen-on-Rhine after the disaster of September 20, 1921, with the plan of the works accompanying Major Theodore W. Salk's article, "Nitrogen Fixation and the German Disaster at Oppau," in October "Chemical Age," page 48, will indicate clearly the exact location of the explosion and the uses of the demolished structures.

25 is for the purpose of finally purifying the gases from any impurities which might damage the contact material or in any way decrease its efficiency. Some ammonia is generally formed in this cylinder.

The gases then enter the manufacturing circuit through the valve 26 where they join the gases containing ammonia on their way from the catalytic material to the absorbing plant. This absorbing apparatus is, for the sake of simplicity, shown as one simple tube 27, in which the liquid is maintained in circulation by means of a pump 28. The ammonia solution is obtained from the valve 29 and any fresh absorbing

liquid can be compressed into the system either by means of the pump 28 or by any suitable method.

The gases leaving the absorption apparatus 27 pass through a stripper 30 which is comparatively large, so as to enable as much water as possible to separate from the gases which then pass through the outer tube of the spiral regenerator 31; then through the first tubular regenerator 32; through the second tubular regenerator 33; through the contact mass 34, back again through the three regenerators 33, 32, and 31, and through a stripper 35 to the circulating pump 36, which maintains the gas contained in the circuit in motion. The gases then pass through stripper 37, in order to separate off any oil, and then enter the absorbing apparatus 27, in the manner hereinbefore described.

The gases in the circuit are from time to time analyzed, so that any excess of nitrogen or of hydrogen above the proportion in which they combine to form ammonia can be detected, and a corresponding alteration in the composition of the gases supplied to the circuit is made, so that the gases in the circuit are made to attain the requisite composition. As the reaction proceeds, especially if a gas containing a small proportion of methane be employed, there may accumulate in the circuit an indifferent gas, in particular, methane, and when this attains a certain percentage it becomes advisable to empty the gases from

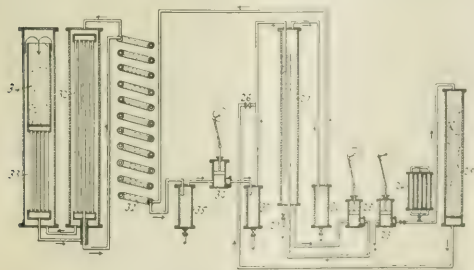


Fig. 4. Diagram of Apparatus and Procedure for the Synthetic Production of Ammonia.

the circuit and replace them by fresh gases. Those removed from the circuit can be purified in any convenient manner and then returned to the circuit, as they are needed.

Utilization of Ammonia

As there is a comparatively small market for aqueous solutions of ammonia, it is generally preferred to transform the ammonia into ammonium sulphate, or else to separate the ammonia from the water and convert it into the liquid form, which can then be preserved in steel cylinders and is then in a suitable form for transport. As a general rule, the aqueous ammonia solution has hitherto been heated and the gaseous ammonia which is driven off is either absorbed in dilute sulphuric acid, for the purpose of making ammonia sulphate, or else it is passed over quicklime in order to dry it, and it is then passed to the compressing machine. It has, however, been found that the ammonia can be obtained in a pure form free from water and oil by driving off the ammonia from the solution, cooling the gas, then compressing it and finally subjecting it to fractional distillation under pressure. The ammonia is then obtained in a form which is immediately suitable for compression, without its being necessary to pass it over quicklime or the like.

Should it become necessary to replace the catalytic agent, this can be done very conveniently and with a minimum of dismounting the apparatus by sucking out the catalytic agent by means of a vacuum, and it is preferred at the same time to pass a current of nitrogen through the vessel so as to prevent oxygen coming into contact with the hot walls of the catalytic furnace. Fresh catalytic agents can then be introduced into the vessel and the process re-started.

Communications

A Word of Praise

Editor, CHEMICAL AGE:

Permit me to congratulate you on your article on the American Institute of Chemistry, appearing in the August number of CHEMICAL AGE. I have read this article twice and am very much impressed with the contents.

Newark, N. J.

September 8, 1921.

A Suggestion

Editor, CHEMICAL AGE:

I would like to suggest that the column editorials on pages 369 (September CHEMICAL AGE) and 417 (October CHEMICAL AGE) be reprinted and sent to every chemist in the United States; also the articles entitled "American Institute of Chemistry" in the August and October issues.

Owing to prolonged absence from the office, I have just had opportunity to read them.

From personal experience and observation, matters have come to a fine pass in American chemistry when independence in thought and action must hesitate to learn first the opinion of a chemical oligarchy.

Chicago, Illinois.

October 25, 1921.

A Cry For Help

Editor, CHEMICAL AGE:

In all your editorial discussion you display a clearness of vision and soundness of principle and aptitude of expression that make CHEMICAL AGE the most readable trade publication in the chemical industry; but what do you mean when you tell chemists it is a God-send that the high-brow has not as many children as the section-hand?

You not only have disturbed this organization, but make necessary an explanation to the women folk; so please elucidate.

Rochester, N. Y.

October 22, 1921.

Our correspondent refers to an editorial in October

CHEMICAL AGE inspired by a perusal of the newspaper reports of the Second International Council of Eugenics held at the American Museum of Natural History, New York.

Progress is the work of exceptional men who inspire the less capable with a measure of their own enthusiasm, and who in turn still pass it on—and so we have the procedure not only of popular education but of every movement throughout recorded time that, however great the ebb and flow of change may have been, has left man higher than it found him. It is quality not quantity that counts in human leadership.

Many criticize present conditions with the air of having made a discovery unique to the era, when as a matter of fact any particular condition affecting biological relations of which they may complain always has existed.

The instincts and emotions that rule men today always have dominated their activities. We now bring to bear upon their study an acuteness of intellect for which we are indebted to the flowering in the western world of the inductive philosophy, and think that the prolific results of such study reveal something strange to the experience of the race.

Man epitomizes in his brief career the biological history of the race. In the prolific provision of the fungus for its perpetuation, or of the fecundity of the fish to the procreative deliberation of the pachyderm, we have, as it were, a mirror in which the race can see itself.

Have we made ourselves clear in showing how natural it is, with the development of foresight, thrift, a desire to give to those whom we may bring into the world the advantages we have enjoyed—to say nothing of the fundamental biological characteristics of human progress, that the race dies at the top and ever renews its virility at the bottom?

Should the high-brow contradict Nature, have you any assurance that, despite occasional examples to the contrary, his offspring will have his measure of helpfulness to the race?

We think not, for one's ability to help others is determined by his ability to help himself. This latter attribute can be acquired only by exercise, by demonstration, by failure and try again.

To relieve men of the necessity of effort does not contribute to growth. To deny to those in the sub-basement of social progress the God-given opportunity of growth, by overloading the field at the top, would create a condition not in Nature's contemplation as it is revealed to man.

We beg to assure our correspondent that we have no desire to encourage controversy among members of his organization, and trust that the foregoing may clarify the meaning of his quotation from the October editorial.

Circumspection Recommended

Editor, CHEMICAL AGE:

Why is it not sufficient that the idea of the American Institute of Chemistry rise or fall on its own merits? If the proposed economic or professional organization of chemists has sufficient merit, as I believe it has, I see no reason why it should not make its own way independently of the consideration of any other organization.

November 9, 1921.

The late receipt of the above letter compels the postponement of its reply to the December number of CHEMICAL AGE when it will receive the consideration that the prominence of its writer and the high character of his service to applied chemistry demand.

Control of the Darkening of Dehydrated Potato

By H. C. Gore and L. F. Rutledge

Bureau of Chemistry, U. S. Department of Agriculture

DURING the war dehydrated Irish potato was manufactured in the form of dried sliced potato, or dried riced potato. In preparing the first named product, the potatoes are peeled, trimmed, sliced from $\frac{1}{8}$ — $\frac{1}{4}$ inch thick, cooked in hot water or steam, spread on trays and dried until brittle in a current of hot air. Dried riced potato is made by peeling and trimming the potatoes, cooking in hot water or steam until soft, forcing while hot through small holes in a die-plate and receiving in trays and drying.

When freshly prepared by either of these methods, dehydrated potato is of a pale amber color, almost colorless. Upon keeping at ordinary temperatures slow darkening usually occurs, commercial samples often turning quite brown at the end of a few months. In the case of dried sliced potato, the darkening usually starts at the interior of the slice, gradually spreading to the exterior. The change in color of dried riced potato is more uniform, although individual pieces often darken in advance of others. Dehydrated potato which has darkened in storage is far less attractive to the eye than when freshly prepared, and the simple methods for the control of the darkening resulting directly from the experimental work described below, should be of practical value.

When the experimental work was planned, the circumstances under which the browning occurred were obscure. We knew that the darkening was slower the lower the moisture-content, and that it occurred at moisture-contents well below those at which the activity of micro-organisms ceased. Dr. C. Thom of this Bureau, in making a micro-biological examination of typical darkened dehydrated potato, found no visible forms of micro-organisms in the tissue, and found it to be nearly sterile. We knew also that the darkening occurred in the soluble ingredients of the potato, as on soaking discolored dehydrated potato in water, the brown color slowly diffuses into the solution. It was suggested to us that the darkening was due to enzymes which had survived the cooking and drying. We had at that time no evidence to confirm or disprove this supposition.

The experimental work was so planned as to give direct information as to the moisture-content to which dehydrated potato must be dried in order that the discoloration upon storage in air-tight containers should be indefinitely delayed, to determine whether or not enzymes were concerned in the color change, and finally to study the effect of storage temperature on the rate of color deterioration.

Experimental Work

Both forms of dehydrated potato, sliced and riced, were prepared in the laboratory. In preparing dehydrated sliced potato, peeled potatoes (Irish Cobbler) were cut into pieces $\frac{3}{4}$ inch square and $\frac{1}{4}$ inch thick by a cubing machine, dipped in cold water and blanched by heating in live steam at atmospheric pressure. Two-minute and twelve-minute periods of exposure to the steam were given in two experiments. As soon as removed from the steam box, the hot stock was spread on drying trays and warm air at a temperature of 120° F. was forced through continuously at gentle pressure. A steam-heated forced-draft dryer was used in which the air was renewed continuously.

Dehydrated riced potato was prepared by heating the peeled potatoes in live steam at atmospheric pressure for 40 minutes; they were then forced while hot through a die plate with holes $\frac{5}{32}$ of an inch in diameter, received on drying trays and dried in the same dryer with the sliced potato.

When dried until thoroughly brittle, a sample of each lot was removed and the drying continued. Sampling was repeated at intervals, and a series of samples gradually decreasing in water-content was thus prepared from each lot of potato.

The samples were placed at once in dry quart-size glass fruit jars, completely filled and sealed air tight, using rubber rings. Each sample consisted of at least three jars of dehydrated potato. One jar of each sample was placed in cold storage at 35° F., another kept at room temperature averaging about 75° F. and another in an incubator at 100° to 105° F. All samples were kept in the dark.

The moisture-content of each sample was determined by grinding a sub-sample of a few ounces very carefully to below 2 mm. in size in a hand-power coffee mill, then weighing out portions and drying in vacuo to constant weight at temperatures below 70° C. In grinding, the burr was set loosely so as to minimize the production of fines on account of the danger of driving off water as a result of heating due to attrition. The drying period and moisture content of each sample is given below:



Steam-heated Dryer Used in Dehydrating the Potato

LOT I. Sliced— Steamed 2 min.			LOT II. Sliced— Steamed 12 min.			LOT III. Steamed 40 min.—Riced		
Temp.	Moisture- Content	Hours	Temp.	Moisture- Content	Hours	Temp.	Moisture- Content	Hours
75	8.62	8	75	8.62	8	75	7.23	8
75	7.11	10	75	8	10	75	4.78	10
12	6.27	12	75	6.62	12	75	4.34	12
14	5.41	14	75	5.41	14	75	4.15	14

They were examined at the end of 222 days and 700 days. No change in color occurred in the refrigerated samples. Even after 700 days' storage, the fine bright color of the original dried potato was preserved unchanged. This result shows that under refrigeration color is retained indefinitely.

After 222 days of storage at room temperatures, the dehydrated sliced potato containing 8.62 and 7.81 per cent. of water had darkened perceptibly. No color changes occurred in the samples of riced potato. After 700 days of common storage, all of the samples of sliced potatoes showed some darkening. It was very slight in the samples containing under 6.27 per cent. of water. Each jar, however, contained a few slices showing marked internal browning. The five lots containing 6.62 per cent. of moisture and over, were distinctly browner than those of lower water content. Of the riced potato kept at room temperature for 700 days, sample A containing 7.23 per cent. had browned slightly, the color of the remaining lots remaining unchanged. These results show that the maximum moisture content destined for prolonged storage at room temperature at and below which practically no color deterioration will occur, lies between 6.27 and 6.62 per cent., for dehydrated sliced potato, and between 7.23 and 4.78 per cent. for dehydrated riced potato.

After 222 days of storage at 105° F. all of the sliced potato samples were badly browned. Those of the higher moisture-content were browner than the others. Of the riced potato series, the sample containing 7.23 per cent. moisture was slightly brown, but the color was less intense than that of any of the sliced samples. The remaining samples of riced potato showed very slight almost imperceptible darkening. After 700 days, all of the sliced dehydrated samples had become very dark, the lots containing most moisture being almost black. The riced potato had also darkened considerably, but by no means as severely as the sliced potato. Incubator

temperatures thus cause far more rapid deterioration than common storage temperatures.

In none of the stored samples could any changes be found which could be ascribed to differences in the blanching treatment previous to drying. In case of the dried sliced potatoes a heat treatment six times as severe in one case as in the other, at a temperature above that at which most enzymes are destroyed, produced no effect on the rate of browning of the dehydrated product. This result indicates that the browning is not due to an enzyme.

From this work it is clear that the browning of dehydrated potatoes can be controlled either by keeping in cold storage or by drying to a sufficiently low moisture-content and keeping in air-tight containers. Storage temperatures materially higher than room temperatures should be avoided, as exposure to high temperatures shortens the period for which the dried potatoes keep without deteriorating.

Summary

Samples of dehydrated sliced potato and dehydrated riced potato containing varying amounts of water were prepared and stored in air-tight containers at three different temperatures. Two-minute and twelve-minute cooking periods were used in preparing the dehydrated sliced potato. A study of the rate of development of the browning in the dried samples gave the following results:

- (1) No darkening occurred in any of the lots kept in cold storage at 35° F. during a storage period of 700 days.
- (2) The moisture content at and below which darkening during storage at room temperatures is so slow that it is of no practical importance, was found to lie between 6.27 and 6.62 per cent. for dehydrated sliced potatoes and between 4.78 and 7.23 per cent. for dehydrated riced potatoes.
- (3) Browning was far more rapid upon storage at incubator temperatures of 100-105° F. than at room temperatures averaging about 75°.
- (4) No difference in rate of browning in storage occurred which could be ascribed to difference in time of cooking before drying.

International Textile Exposition

The Textile Exhibitors Association, Inc., of which Edgar F. Hathaway, vice-president, Shawmut Engineering Co., Dorchester, Mass., is president, has reason to be proud of the success of its latest textile exposition, October 31-November 5, at Mechanics Hall, Boston, Mass., which, on account of the development of export trade in textiles and the primacy of cotton as an export product, was called "The International Textile Exposition."

Textile manufacture falls within the "allied" group when we speak of the "chemical and allied" industries, for not only is it chemically controlled but a large consumer of chemical products used throughout the procedure of manufacture from the treatment of the textile raw material to the finishing and dyeing of the fabric. Many chemical concerns had representation at the exposition in a manner befitting their service to the textile industries, those most familiar to our readers being the National Aniline & Chemical Co., E. I. du Pont de Nemours & Co., Parks-Cramer Co., Bahnsen Co., etc.

The exhibition was divided into five departments, two being devoted to general textile machinery, including the cotton, woolen knit goods and hosiery industries, one to mill construction processes, one to the power and supply departments and another to finished products and light machinery. Over 300 exhibitors, with materials and machinery on display of

value aggregating \$2,000,000, contributed to make the exposition the most successful in the history of the textile industry.

One aspect of the exposition of interest to chemical equipment and supply manufacturers and to manufacturing chemists is the fact that this great industry conducts its exposition through the medium of an association of exhibitors whereby the expense of the show is borne by the exhibitors participating. The officers of the association include, in addition to President Hathaway, Frank J. Hale, Lowell-Saco Shops, vice-president, and Chester I. Campbell, treasurer-secretary and general manager, with offices at 5 Park Square, Boston, Mass.

"Dyestuffs," for November, the monthly magazine of the National Aniline & Chemical Co., 21 Burling Slip, New York, issued contemporaneously with the Textile Exposition in Boston, is of especial interest to dyestuffs users in the textile fields. In addition to a description of the technical service of the company, is an informative article by M. D. C. Crawford, Research Associate of Decorative Arts of the Brooklyn Museum, on "The History of Textiles in the New World." The cover design appeals especially to the textile antiquarian. In it are reproduced in original colors the designs of fabrics of historic interest in the evolution of textile art in America from the oldest known cotton fabric to the finest modern products in cotton and silk.

The Influence of Cheap Oxygen

By E. A. W. JONES

Consulting Engineer

THE advent of cheap oxygen as the new industrial giant is destined to take an important part in material progress in the more efficient utilization of fuel, particularly in the reduction of cost of manufacture of gas and steel and of many other great staple commodities of modern life.

We are all familiar with the small cylinders of compressed oxygen now to be seen everywhere blowing the breath of life into acetylene gas and performing the miracle of cutting steel as a band-saw cuts wood, or of welding metals with equal rapidity—certainly a most useful function, but only a beginning limited by the cost of separation, compression and distribution. The filled cylinder costs at the rate of \$10-15 per 1,000 cu. ft. of free oxygen, which is 100 times too costly for any general use by industries concerned with fuel economy. In fact, before it can come into general use on a large scale for such purposes its cost must be reduced to cents instead of dollars. I am privileged to announce to members of this society * that the problem of the cheap production of oxygen has been solved.

The New Method

I shall not attempt here to explain in detail how it is done beyond saying that in general the process comprises liquefying air by compression and expansion, and then distilling off the nitrogen, just as is now done by the Linde and other processes; but instead of consuming large amounts of power to drive compressors and then throwing practically all the work away by free expansion in the still, the new method is based on the simple idea of carrying on the distillation under pressure, that is at the pressure to which the air is originally compressed. By this means the nitrogen, or most of it, which is 80 per cent. of the whole volume of the air, leaves the still under the original pressure. It then can be heated to increase its volume and power capacity, and used in a piston engine to drive the compressor.

For this purpose, as students of elementary thermodynamics well know, very little heat is required to do a lot of work because the efficiency of conversion of heat put into a gas already under pressure is about 75 per cent., whereas only about 15 per cent. of the heat put into raising steam is converted into work. By these simple means which only involve the mixture of a little common sense with established facts and sound engineering, a method has been evolved which requires no external power to operate, but uses instead a comparatively small amount of fuel.

Nature imposes only a small resistance to the separation of a mixture of gases, in fact only about 3 H. P. is required theoretically to separate 1,000 feet of oxygen per hour from the atmosphere, and the new method, when applied on a large scale, works at about 60 per cent. efficiency, which is ten times as efficient as current practice. The combined effect of these two favorable factors, viz., high process efficiency and that the small amount of power required can be supplied by heat instead of requiring the use of external power, results in our ability to produce oxygen at a cost ranging from 8 cents per 1,000 feet when produced at 4,000 feet per minute to 28 cents per 1,000 feet when produced at 400 feet per minute. These figures, of course, will vary with local cost of fuel and labor, but represent

a fair average and include all factors entering into a commercial operation, except taxes. Interest and depreciation is figured at 16 per cent. of capital invested.

This new method has been put into practice and successfully demonstrated on a large scale, not in the production of oxygen, but in the separation of helium from the natural gases of Texas, which is an almost infinitely more difficult task.

The helium work for the government has been concluded, at least for the present, and the way now is cleared to proceed with the oxygen program. That is why I am able to state not only that the problem of cheap oxygen has been solved, but that it shortly will be available for use; that is to say, steel plants and many other industrial activities shortly will be equipping themselves with oxygen-separating apparatus and piping that useful gas around the works for general use.

I will not endeavor to outline a few of the purposes which cheap oxygen will serve, all of them relating to the conservation of fuel or of time, or both.

Cheap Oxygen in the Production of Fuel Gas

This application was the subject of a special study presented in a paper read last February before the New England Association of Gas Engineers. It clearly shows what result can be expected when oxygen, instead of air, is blown with steam into the gas producer, viz., that there will be produced from a ton of good gas coal 69,000 cubic feet of the most valuable quality of gas containing 400 b. t. u. per cubic foot. All that is required to do this are (1) a good gas producer, (2) 2,240 pounds of gas coal, (3) 672 pounds of dry steam and (4) 14,000 cubic feet of oxygen.

The oxygen, if produced in a moderate-sized plant, will cost from 10-12 cents per 1,000 feet, i. e., about \$1.50 per ton of coal gasified. The total present cost of coal and steam, oxygen and labor, interest and depreciation, in such industrial centers as Pittsburgh and Chicago is about \$5.50 for 69,000 cubic feet of gas containing 400 b. t. u. per foot, i. e., about 8 cents per thousand (figuring coal at \$2.50 per ton delivered at works), based on making 10 million feet per day.

This constitutes a prospect of the greatest conceivable importance, not only on account of low cost, but because such gas contains 58-60 per cent. of that most effective of all fuel gases, namely, carbon monoxide, whose flame temperature, as combustion engineers know, is higher than that of any other gas in general use—very much higher than that of methane or natural gas. The balance consists of hydrogen, methane and illuminants with only 5 per cent. of non-combustibles (N, CO₂).

Such a gas is more generally useful than either coke-oven gas or natural gas, because while these latter gases contain more b. t. u.'s per cubic foot, their flame temperature is lower, especially natural gas, on account of the much larger quantity of air required to burn it. The steam-oxygen gas easily can be piped around and is ideal for every purpose in a steel plant, although it is not claimed here that it will prove more economical in the open hearth furnace than ordinary producer gas. We shall see later that it will probably be more effective to introduce oxygen direct into the open hearth furnace with producer gas for making steel; although the use of producer gas at all is debatable on

* Presented at the 15th annual convention, Chicago, September 19-23, 1921, of the Association of Iron and Steel Engineers.

account of the fact that over 50 per cent. of its volume is useless nitrogen, which only serves to consume fuel to supply the heat it carries away to the stack.

This simple process of directly converting bituminous coal completely into gas by a mixed current of steam and oxygen is of very great importance to the public service companies, being in fact of an almost revolutionary nature in the matter of public gas supply; but that phase of the subject is not of prime importance here today. The same method, however, provides an ideal gas, generated in a central station, for distribution to all mill furnaces, and especially for firing coke ovens and for mixing with the gas from the coke ovens to augment the general supply around our steel plants and rolling mills.

Cheap Oxygen in the Metallurgy of Iron

The advantage to be gained by the use of oxygen in the open hearth furnace is in speeding the operation and cutting down the amount of gas consumed proportionally. You all know that about 10 hours' time is required to melt and oxidize the charge in a large standard furnace, and this long period consumes a tremendous quantity of gas, which slowly imparts its heat to the charge. The charge absorbs the heat from only about 100 pounds of coal per ton of steel, and the unavoidable losses from radiation amount to about 100 pounds more. Yet we use at least 600 pounds, due to slowness of action. Why? Simply because the temperature of the burning gas is so little above the melting temperature of the charge that the transfer of heat cannot take place rapidly. Every melter knows how much difference a few degrees of temperature makes in the time required. If the flame is a little below normal the process almost stops, while a hot clear burning gas speeds it up and reduces both time and fuel consumption out of all proportion to the difference in temperature.

If, therefore, we introduce a small stream of oxygen into the gas ports (about 800 feet per ton of steel), there is every reason to expect a great change in practice—probably a reduction of 50 per cent. in time and fuel which, of course, would greatly influence the cost of making steel. It would involve some change in constructing furnace roofs, but I am assured by certain prominent steel manufacturers that this aspect of the problem presents no great difficulty.

Then there is the much talked of question of supplying oxygen to the blast furnace, which many iron makers believe has a future of real usefulness, both in the matter of increased output and in improved quality of iron; also in largely reducing the consumption of coke. There is, however, no well-defined general opinion on the subject, nor is there likely to be until oxygen is produced cheaply in large volume, so as to offer the opportunity for trial. At the present time there is not oxygen enough produced in the whole United States to operate one standard blast furnace. Designs have been prepared, however, which show clearly what the cost will be, and the figures are very interesting. They are based on supplying a blast of 50 per cent. oxygen—the probable limit. The present large blowing engines are greatly reduced in size and the stoves are eliminated. The oxygen plant uses less gas than the stoves and the result appears to be a saving in initial cost on a 500-ton furnace of about \$250,000.00 without allowing for increase in output. There is good ground for expecting a reduction in the cost of making pig iron, on the average, of about \$2.00 per ton.

Then, too, there is the added prospect, still more

alluring, of reducing the ore direct to crude steel in the blast furnace ready for final refinement in the electric furnace, which many believe to be the probable outcome of using oxygen. There are many miscellaneous uses for oxygen around a steel plant for cutting up metal and welding parts together, and for stimulating combustion everywhere, which means reduced fuel consumption, because wherever the oxygen supply is increased the time factor is reduced and the vast quantity of hot nitrogen which now escapes to the air is also reduced.

Heat Conservation

Have you ever stopped to think of what becomes of the bulk of the heat generated by all the coal taken from the mines? Steam boilers, it is true, convert it into usefulness with a fair degree of efficiency, which is only susceptible to a moderate improvement; but what about our heating, melting and smelting processes which consume the bulk of the bituminous coal reaching our metallurgical, glass-making, chemical and clay-burning industries? You will readily agree that the majority of this vast volume of heat is carried into the atmosphere uselessly in the form of hot nitrogen. The principal burden of practically all smoke stacks (so called) is hot nitrogen, which represents about 75 per cent. of all the labor of both nature and man in creating, mining, transporting and burning fuel for the purposes mentioned.

The only active hope of reducing this enormous waste lies in separating part of the nitrogen from the air used in combustion and using a much larger proportion of oxygen. By so doing not only will we greatly economize in fuel, but will correspondingly speed our processes, both factors contributing largely to reduction in cost.

Miscellaneous Uses of Cheap Oxygen

I will not here do more than mention other industries in which large economies in fuel and time will be effected by the introduction of cheap oxygen; such as, for example, the manufacture of sulphuric acid, that other great standard of modern civilization which those engaged in the industry estimate will be cheapened by one-third the present cost.

Then there are the calcium carbide and nitration fields of fertilizers and explosives, very great industries which are affected to an equal degree not only by cheap oxygen, but also by the fact that the nitrogen, which is needed in this industry, is a by-product without extra cost to produce.

I also might point out the very great increase in the use of welded joints in boiler-making, ship-building, structural work, etc., which is made inevitable by cheap oxygen in combination with the fuel gas spoken of earlier, which is ideal for the purpose, costing only about one-tenth as much as acetylene per unit of work done. I might weary you with a catalog of such prospective benefits to humanity which must inevitably follow this oxygen development now well started, but will avoid doing so by closing these remarks with the sincere hope that many will take my words to heart and prepare themselves, each in his own industry or field, to reap part of the reward awaiting those who are found ready when the call comes.

In concluding I want to refer to the very excellent paper on this same general subject presented by Dr. Frederick G. Cottrell on "The Future of Oxygen Enrichment of Air in Metallurgical Operations" before the American Iron & Steel Institute, May, 1920.

Improvement in Patent Office Conditions Imperative

Report of Thomas E. Robertson, United States Commissioner of Patents.

THE Patent Office is in a deplorable condition.

In July, 1919, the then Commissioner, Newton, testifying before the House Committee on Patents, said:

I have been connected with the Patent Office since 1891, and I am sure that the Office was never in so poor a condition as it is now.

From that time, July, 1919, to June 30, 1921, the Patent Office suffered a loss of 163 examiners. These men who were *scientifically trained and also members of the bar* have been replaced by inexperienced men, fresh from college, without any knowledge of patent law or any legal training. Moreover, the men who resigned were familiar, through years of experience, with the particular art with which they were engaged, and it takes years to train new men to take their places.

During the time that the Patent Office has been losing the 163 men aforesaid, the number of applications received in this office has increased by leaps and bounds. In the year preceding former Commissioner Newton's testimony the Patent Office received 62,755 applications for patent; in the fiscal year just closed, June 30, 1921, it received 84,248 applications, an increase of 34 per cent. Trademark applications jumped from 8,561 to 15,884, or an increase of 85.5 per cent.

The loss of 163 legally and scientifically trained examiners out of a force of 437 would make it impossible to keep up the work even if there had been no increase, but since, during the period referred to, the patent work has increased 34 per cent. and the trade-mark work 85.5 per cent., the situation has become hopeless. This is graphically shown by the fact that when Commissioner Newton testified in July, 1919, there were 18,000 patent applications awaiting action, whereas when the new administration began in March, 1921, there were 42,000 applications awaiting action, and at the close of the fiscal year 1921 there were 49,000 applications awaiting examination.

The actual situation is further shown by the fact that a number of divisions are over eleven months behind with their work. As one example, reference may be made to one of the chemical divisions where five out of nine examiners have been appointed in the last few months. At the close of the fiscal year one of these had been in the office only one week, another three weeks, another seven weeks, another two months.

One out of every four examiners has resigned in 16 months and more than one-half (or 231 out of 437) have resigned in 32 months.

Relief Is Imperative

The *only* way to stop the continuous stream of resignations is to increase the salaries.

These examiners, paid in 1848 the same as Congressmen (\$2,400), have had an increase of only 10 per cent. since that time. House bill 7077 is designed to remedy partially the situation and to provide slightly larger salaries for the examiners, pending the general reclassification of Federal employees. Some increase is necessary to get suitable men to fill the vacancies and to retain the men already in the office.

The same bill also increases the fees, so that relief is provided without costing the taxpayer a single cent.

The Patent Office is breaking at the very moment it should be responding to the fullest extent to the depressed industrial conditions of the country. The Secretary of Labor reports that there are over 5,000,000 unemployed in this country and the Patent Office should

be helping to provide new avenues for employment, whereas it is retarding industry by holding up for a year or more patents upon which new industries would be started.

Salary Comparisons Entrance Conditions

The entrance salary of assistant examiners is \$1,500 per annum, while the entrance salaries of clerks of city postoffices is \$1,400. Assistant examiners must take a three-day examination in higher mathematics, advanced chemistry and physics, one foreign language, technics (embracing the application of the sciences to all the mechanical, electrical and chemical industries), and the reading of mechanical drawings, while the candidates for postal clerks take but one day's examination, based upon the requirements of a common school education.

The position of insurance claims examiners in the Bureau of the War Risk pays an entrance salary of from \$1,800 to \$2,500, although the Civil Service examination covers a time of only one day and the qualifications are based upon a common school education and a course in and graduation from a law school. The candidate for entrance into the examining corps of the Patent Office, not only takes a much severer course of study than the candidates of either of the other positions mentioned, but he has to pass the most exacting examination of a general nature given by the Civil Service Commission. These instances are cited as illustrative, among many others that could be given, of the inequality of conditions and as one of the main reasons for the present critical situation in this bureau. In fact, by comparison, the position of patent examiner has degenerated from the best paid to one of the poorest paid of the technical positions in the Government service.

Finances

The outstanding feature of the year's business is not only the maintenance of the abnormal volume of work which was presented the previous fiscal year, but its decided increase. In applications for patents for inventions received, there was a gain of 22 per cent. over the fiscal year 1914, the heaviest year before the war, and 35 per cent. over the fiscal year 1918; while in the total applications received (including trade-marks and designs), there was an increase of 32 per cent. and 47 per cent., respectively.

The receipts of money increased from \$2,615,697.33 to \$2,712,119.69, or almost \$100,000. The expenditures increased at greater rapidity, from \$2,427,776.76 to \$2,640,373.96, or over \$200,000 more than the previous year, reducing the net surplus from the year before from \$179,135.96 to \$71,745.73. Most of the increase went into printing and photolithographing on account of the increased cost of such service in the Government Printing Office and the increased bids from the contractor for reproduction work. Part of the last named item, however, is offset by a large increase in the stock of copies of patents for sale.

It is apparent, from the figures given and the conditions cited, that the business presented to this office is altogether too large in volume for the present personnel to properly perform, and that unless remedial measures are effected to provide both an increase in force and salary sufficient to provide a competent and experienced personnel, the present deplorable condition will become intolerable.

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A Consolidation of
The Chemical Engineer
and Chemical Age



THE chemical industry as we commonly think of it feeds the allied industries whose products flow into the varied distributive channels to the consumer. General production activity, the reduction of unemployment, in the chemical field await the stimuli of increased purchasing capacity of the people, felt not so much directly as through the industries whose essential raw materials are the products of chemical enterprise.

Despite spotted improvement, especially that in manufacturing lines that have undergone marked deflation in production costs or are in a position to reflect seasonable demands, much remains to be done in re-establishing the sound basic conditions essential to a superstructure of prosperity, which is simply the exercise of the power to buy needed goods and services.

We all are receptive to the exhortations to reduce production costs but feebly responsive in a situation that provides not a volume of consumption that makes greater manufacturing economies practicable. The fact is we are oversupplied with production facilities, and world conditions make their capacity operation the subject of slow and, in too many cases, uncertain growth.

High taxes levied in a manner to strangle enterprise, group action among politicians and union labor to penalize the mass to its own profit and the poverty and disorder of the buyers of our surplus production are outstanding deterrents to the satisfaction of the suppressed appetite of the country for goods.

The solution of small problems awaits that of greater ones; our national problems are but the local reflection of greater problems that grip the world. The earth today has a measure of compactness never felt before, which makes economic isolation impossible and which should drive home to every man a greater sense of individual responsibility in a greater world society. The problems of the plant manager and the hopes of the chemist out of a job are but a local reverberation.

IN a country that, for every dollar, collected from its citizens, spends 92.3 cts. on account of the unproductive and destructive purposes of war—ill-adjustment of prices, inequality of purchasing power, the slow recovery of business and reduction of idleness have a minor significance in comparison with the necessity of reducing this primary burden upon the consumer.

Economic conditions not only compelled the call of the conference for the limitation of armaments, but likewise will demand that the material burdens of existence be lightened of this perversion of the constructive forces of the world.

Reduced taxes or their equivalent applied to national development, formerly wasted in the results and anticipations of war would have a material and moral influence incapable of estimation. Here is a problem in the elimination of waste that embraces the world and yet touches the management of every enterprise and the purse of every citizen.

THE relation of corn to hog and to ham and to lower food costs generally is the same as that of coal consumed solely for coke to its status as a basic chemical raw material.

The degradation of corn to fuel because of the privileged labor-cost ingredient of coal and transport compels comment, for it epitomizes the fundamental maladjustment in American life and industry that must be corrected before domestic business conditions can become stabilized and activity in the interchange of goods and services can become general.

PERUSAL of Mr. McDonald's article, "Synthetic Organic Chemistry Our National Salvation," in this issue of CHEMICAL AGE will put one in a frame of mind to appreciate the importance to industrial organic chemistry, and through it to the nation, of coordination in the development of this fruitful field of applied science. The aims and functions of the Synthetic Organic Chemical Manufacturers' Association of the United States exemplify the highest type of trade organization.

A trade association founded to advance the science of its art, to promote public knowledge of its importance to national welfare, to cultivate cordial commercial relations among its members, to inculcate high standards of business ethics, to co-operate with government to establish industries essential to the common good and to present a united front to organized foreign activity that would undermine it, certainly merits the good will that always goes with high resolves.

As a timely aspect of the growth of applied science the industries concerned represent waste utilization, and hence conservation of our resources, of the most beneficent character. Mr. McDonald, in his emphasis that the present is an age of synthesis, shows how the development of a rounded, interdependent organic

chemical industry in America is possible only by close co-operation of the production activities of existing units, and enables us by his article to encourage the best wishes for the success of this important association of chemical manufacturers.

KINDRED with Benjamin Franklin (1706-1790), Thomas Paine (1737-1809), and Thomas Jefferson (1743-1826), Joseph Priestley (1733-1804) suffered for his sympathy with the French Revolution, and sought asylum in America.

Non-conformist and dissenter that he was, today would find his predilections, fearless of conventions, in favor of the fullest measure of independent thought and action in the firm belief that men prize most highly what they work for and win.

In the divine urge for exercise and self-creation human nature soon surfeits of what is done for it, and rises in resentment when the opportunity is denied or sought to be preempted by those who feel they have a vested right.

CONTEMPORANEOUSLY with the highest known volume of unemployment among chemists is the demand for chemical instruction that surpasses existing facilities of education. With the increased application of capital and effort to the production of chemists comes the question of the capacity of industry to absorb them—whether or not their production is at a rate that inflicts hardship in the work of adjustment of the man to the job.

Unusual war-time production gave chemical workers such opportunity as encouraged greatly accessions to their numbers but which peace-time reaction not only left stranded but made more drastic the operation of natural selection. Reabsorption in normal production will be slow and with the distress always incident to a condition of more men than jobs.

In the face of the operation of the law of supply and demand and with the current glorification of the chemist and his work, which we feel should be tempered with bread-and-butter information, the situation calls for a measure of regulation that has been applied under similar conditions in other lines.

This regulation should begin with the selection of students and be handled in industry by chemists themselves in a professional organization dedicated to the inculcation of standards of capacity and the displacement of men who only dilute a body whose label should be efficiency to industry and to self.

The appreciation of the importance and difficulties of this subject by chemical educators should impel them to encourage the formation of a professional society whose organized help as a bridge from the university to industry would be a most constructive influence in the production, use and growth of the human raw material of chemical industry.

THE breadth of mind and vision of the members of the Stamford Chemical Society are indicated by the presence on its executive committee of a representative of the local press. In this society we have an example of self-creating, self governing, self-responsible, economic chemical organization, adapted to individual and community needs and easily coordinated with similar activity in other cities of the state to form a representative state organization responsive in its roots to the needs and aspirations of chemical enterprise and its personnel within the state, and so providing on a wider scale a basis of rivalry among similar state organizations in service to educated chemical workers, to the community, to the state and to the nation.

This is democratic chemical organization, with the fullest self-determination and with its usefulness conditioned only by the ambition of the individual, in contra-distinction to oligarchical organization well suited to pedagogical discipline as befits a scientific society and equally so to the opportunism of class that always doth hedge about the sovereign.

In the chemical oligarchy the few think for the many and decry enterprise that may disturb the system. In economic organization of chemically educated men on state lines designed solely to develop the fullest opportunity for the widely variant chemist to make the most out of himself, the many think for the few and get only what they have the ambition to strive for; which from the standpoint of the development of the individual's potentialities is a vastly more fruitful procedure than a system that seeks to relieve its members from exercise that necessarily may disturb it.

As an instrument to aid and systematize the process of natural selection in a field of work increasingly drastic in its intellectual requirements and to study the potentialities of its personnel that every shade of chemical capacity may find a full measure of its hope, the American Institute of Chemistry is an eventuality as certain as is the success of the American Institute of Chemical Engineers.

The conditions that forty years ago in Great Britain made desirable the Institute of Chemistry of Great Britain, which the interim has proven good, and which analogous and more commanding conditions today give rise to the Canadian Institute of Chemistry, can be made inoperative only little further in America. What is good for British and Canadian chemists is good for American chemists.

Such economic organization of chemists can be worked out successfully only on state lines; it is not a national proposition. Discouragement of the growth of this idea by any organized body, or, finally seeing the futility of such discouragement, seeking to add its essential purposes to its omnibus organization, will thwart its beneficent operation and so do the science and art of chemistry a positive disservice in a field so great that rivalry in service to its personnel is demanded.

Natural Gas-Gasoline Blends

By D. B. Dow

Assistant Petroleum Chemist, Bureau of Mines

NATURAL gas-gasoline is made by collecting in the liquid state the condensable hydrocarbon vapors that exist in different natural gases in varying amounts. In the richer type of natural gas the gasoline is generally recovered by compression and cooling. If exceedingly high pressure or low temperature is used, there is dissolved in the gasoline a large amount of very volatile material, which evaporates rapidly at atmospheric temperature and pressure.

In the leaner type of natural gas, the gasoline vapors are selectively absorbed from the permanent gases by passing the natural gas through an absorbing oil. The gasoline is recovered by distilling the saturated oil, and as compared with "compression" gasoline is of high Baumé gravity and low vapor pressure. Before a volatile gasoline can be transported in tank cars, it is necessary to decrease its volatility in order to lessen the risk of fire or explosion, as well as to prevent excessive evaporation in transit. This can be accomplished either by weathering the gasoline, or by blending it with a more stable material, naphtha being commonly used. In the weathering process the more volatile portions of the gasoline are allowed to evaporate and the losses in volume are very large. Therefore, blending is preferable, wherever possible.

It is very difficult, however, to produce by blending, in gasoline plants, a motor fuel which is equal to straight-run refinery gasoline. In order to make a blended motor fuel of a grade equal to straight-run gasoline, only a small percentage of natural gas-gasoline can be blended with the naphtha, consequently it is customary to blend the gasoline with only enough naphtha to enable it to be shipped to an oil refinery when the material is again blended to form a finished motor fuel.

The addition of natural gas-gasoline to straight-run products is often necessary, first, to balance the large amount of high-boiling material included in the gasoline fraction in modern refineries, and second, to supply the deficiency of low-boiling material in certain crudes.

In the past, blends were frequently made with kerosene and were subsequently distilled, the kerosene merely acting as a carrying agent for the natural gas-gasoline. However, this re-running was found to be rather expensive on account of distillation losses due to the volatility of the natural gas-gasoline. This particular type of blend was also tried as a motor fuel, but proved to be very unsatisfactory.

The most common blending material now used in the Mid-Continent field is a naphtha ranging in gravity from 50 to 52° Bé., with an end point of 450° F. or less. When this naphtha is blended with natural gas-gasoline, the vapor pressure and Baumé gravity of the blend is much lower than in the raw gasoline, and there is not enough high-boiling material to injure the resultant motor fuel when this blend is added in small amounts to straight-run gasoline.

It is not necessary to use 50-52° Bé. naphtha for blending with natural gas-gasoline, as there are other comparatively volatile petroleum distillates that will accomplish the same purpose. It is quite possible to use straight-run gasoline of 56-58° Bé. gravity as a blending material, when the object of blending is that of bringing down the vapor pressure to conform with shipping regu-

lations. It has been found that blends made with either 50° Bé. naphtha or 56° Bé. gasoline, blended in the same proportion with natural gas-gasoline, will give almost identical vapor pressures. This possibility can be made use of to advantage when 50° Bé. naphtha commands a higher price than 56° Bé. gasoline, or when naphtha is temporarily unobtainable. The Bureau of Mines has found that by rerunning kerosene in the Bartlesville experimental refinery, 20 per cent. of 46° Bé. naphtha with an end point of 450° F. could be obtained.

The present price of kerosene is so low that many refiners are mixing the unfinished material with fuel oil and gas oil instead of refining it. An opportunity, therefore, exists for the rerunning of kerosene distillate and obtaining a naphtha with an end point of 450° F. It should be pointed out, however, that to get yields comparable to those obtained by the Bureau, efficient fractionating towers must be used.

The naphtha produced in this way is an excellent blending material and will reduce the vapor pressure of the gasoline to the same extent as 50° Bé. naphtha. It would not, however, produce a blend which is suitable for motor fuel when used alone, as the mixture would contain an excess of both low-boiling and high-boiling fractions and would be deficient in the hydrocarbons that have medium boiling points. This blend can, however, be advantageously added to straight-run gasoline, since the natural gas-gasoline contained in it will furnish the required low-boiling material.

Efficiency in Baltimore Gas Service

The Bureau of Standards is cooperating in an investigation being conducted in Baltimore, Md., to determine what quality of gas will give the people of that city the best service with the least cost to the consumer. The investigation is being conducted jointly by the Maryland Public Service Commission, the Consolidated Gas and Electric Company of Baltimore, and the Bureau of Standards.

Laboratory tests of the coke-oven gas from Sparrows Point, of different qualities of water gas, as made at the Spring Garden Station, and of mixtures of coke-oven and water gas are being made by the Bureau's engineers. To be able to state what is the most economical standard of quality, it will be necessary to consider the cost of manufacture and distribution of the various qualities of gas, the price of the coke-oven gas, and the relative utilization efficiency of the gases of different composition and heating value.

Baltimore has at present a rather low heating value standard on account of the large amount of coke-oven gas that it receives from the steel plant at Sparrows Point. This gas has normally a heating value of about 500 b.t.u. The supply, however, is not always uniform, and since the gas consumption varies considerably from day to day and with the seasons, it is necessary to make up the deficiency with water gas. Water gas and coke-oven gas differ materially in their composition and specific gravity and this makes it a little difficult to adjust appliances to give good service when the composition of the gas is constantly changing. A careful study of appliances will be made to find out how to overcome this undesirable condition caused by the changing of the two kinds of gases.

Protection from Excess Pressures in Chemical Apparatus

By John S. Shaw

Safety Engineer, Hercules Powder Co.

THE general principles or rules applied to the safeguarding of machinery do not suffice when considering excess pressures in chemical apparatus, for in handling chemicals each safeguard must be designed separately and specifically to meet the peculiar requirements for which it is intended. This is because of the numerous properties of chemicals and the changes constantly taking place between them. General safety rules are often of little use and frequently are positively dangerous if literally applied; for instance, as a general rule, we would use water for fighting fire but a fire involving metallic sodium might be intensified by the application of water.

Let us consider the factors governing excess pressures in chemical apparatus. They are:

(1) heat, natural and artificial; (2) chemical reactions; (3) design of apparatus; and (4) control, maintenance and inspection.

Heat

There are a great many volatile liquids, both flammable and unflammable, which are handled and stored in various containers and innumerable form of chemical apparatus, and proper study must be given to each compound or element regarding its chemical and physical properties. The effect of the sun's rays in generating heat and pressure is in general the same but the risks set up are varied and the specifications for safety when handling chemicals necessarily differ.

The Interstate Commerce Commission has done the country and industry a wonderful service in developing intelligent regulations for the safe handling of chemical compounds and we cannot emphasize too strongly the need of strict observance of the regulations laid down by this creditable organization. As a special reference, see its pamphlet No. 9. The regulations of this Commission should be equally safe for chemical factory practice. The Standard Tank Car Company also has issued a handbook entitled, "All About Tank Cars" which contains the requirements of the American Railway Association and may be obtained from its New York Office, situated in the Woolworth Building.

The variation in temperature and pressure due to climatic changes is serious. A tank car of ammonia liquor contains unflammable but volatile material and when shipped from Milwaukee across the deserts of the Southwest may undergo a change of 50-60° F. in the sun. Pressure changes take place in shipments like this; care of the safety vents, piping, and the degree of filling the car must be observed to see that proper provision is made for maximum pressure. Drums of ether, carbon bi-sulphide and various light petroleum products and other dangerous flammables are sometimes shipped and stored with little regard for proper shelter from the sun's rays. It is impracticable to equip drums with safety valves and hence a greater likelihood of excessive pressure when these containers are exposed to sunlight. Carbon bi-sulphide, for instance, is highly flammable and ignites from little friction at fairly low temperatures. Greatest precaution should be taken to store such compounds in cool and sheltered places. But who is the foreman who would ordinarily think of this if not properly guided?

A safe practice, I believe, is to have the factory's laboratory advised of the expected arrival of not only flammable liquids, but all materials such as compressed gases, metallic sodium, quicklime, etc., as the chemist in charge should make the proper recommendation for handling and storing all chemicals.

The subject of excess pressures from artificial heat sources takes in operation and control and will be discussed later.

Chemical Reactions

Chiefly because of heat and pressure arising from the mixing of chemical compounds, the opening remarks of this paper were written, to wit, that general rules often fail when we adhere to them too literally.

We are taught to fight fire usually with water, but there are many instances wherein excess pressures, fires and even explosions may occur if water is used. Hence the importance of having proper equipment for fighting fires occurring between specific chemicals, and the absolute necessity for not placing them adjacent to one another where trouble might occur if they should come together through leaky or faulty equipment.

As an illustration, we would not store drums of glycerin near a mixed-acid pipe-line; glycerin, in this case, being only one of hundreds of substances which would be dangerous when coming into contact with mixed-acid. Neither would we transport through a common pipe-line or ones which are cross-connected or joined by manifolds, chemicals which react upon each other.

Design of Apparatus

It often has been said that necessity is the mother of invention, but I believe that in ninety cases out of one hundred, accident is the mother of invention, because many improvements grow out of accidents; so the design is based largely upon accidents and the lessons they teach.

Consideration should be given to the strength of materials at maximum possible pressures and the risk to life, as well as surrounding buildings and equipment. The American Society of Chemical Engineers has done very good work along this line and there are many standard references on the subject.

When it is not economical to design apparatus to withstand maximum pressures, proper safeguards should be provided. These may be safety valves, vents, discs, pressure gauges, thermometers, pressure regulating valves or alarms. In many processes excess pressures are controlled by proper agitation, cooling and refrigeration.

In planning the layout of a plant, proper distances between apparatus should be maintained and when such are impracticable, ample barricades or shelters should be provided. Some dangerous operations should be spread out in separate buildings and even then in certain cases it is found necessary to barricade the buildings, or to separate them by screens or fire walls.

All apparatus should be provided, as far as possible, with natural light and should be readily accessible both to the operator and repair man, for nothing is more conducive to neglect of the equipment than remote location. If control valves cannot be reached easily, extension handles or pull chains should be installed.

Next come the connecting links between various op-

*Paper read before the National Safety Council, Boston, Mass., September, 1921.

erations and their apparatus. They are usually pipe-lines, conveyors, gutters, troughs or cars. In general, interlocking pipe-lines with complicated valve arrangement should be avoided. The same may be said of troughs, gutters or car lines. A switch and signal system in the last case would correspond to a complicated valve arrangement in a pipe-line. Where it is necessary to parallel pipe-lines used to convey dissimilar liquids and gases, distinctive and standardized colors or markings should be given each line. Further to avoid confusion and error, the use of semaphores and pointers for day work and signal lights for night, have been found helpful. These are usually more reliable than telephonic control, since the eye is less apt to err than the ear.

All signals and indicators, including pressure gauges, thermometers, pyrometers, monometers, etc., should be well illuminated and easily accessible for good maintenance, as well as for safe operation. Whenever it is imperative that indicators be placed in remote places, the use of periscopic mirrors and telescopes has met with success.

The design should include a complete study of centralized and automatic temperature and pressure control, since automatic equipment is generally more accurate and safer than the human element, provided the operator will keep the automatic equipment in perfect order. It is easier to keep automatic equipment in good working order than it is to operate without it, using only manual control.

The boiling points of liquids must be considered. For instance, in a closed system, such as in the method of ammonia-absorption refrigeration, where the boiling ammonia liquor generates a pressure in excess of the steam pressure of the heating coils, the design should permit easy control of the steam valves, governed by accurate and visible pressure gauges, to indicate actual pressure in the absorption apparatus.

Control, Maintenance and Inspection of Apparatus

We have recommended centralized and automatic control. Not all designs can have both, but many may have one or the other, thus eliminating much error and risk; and if both automatic and centralized control can be combined in one, we have almost an ideal condition.

Many mistakes are made by depending too much upon automatic control. We must remember that everything fails or wears out in time and that automatic safeguards, such as pressure gauges, regulating valves and thermostatic equipment with signal lights and alarms, are far more accurate than man, but they must be kept in good order. To do this, the operator must keep such equipment under his constant observation.

Without automatic safeguards, an operator may attempt to regulate steam pressure by a hand-valve, but variations in the boiler load elsewhere on the plant suddenly may change the main line pressure. If the change is upward, excess pressures might arise and do much damage to apparatus and product, to say nothing of the risk to life and property.

We have had experience in distillation operations where the temperature of the product as distilled was haphazardly observed by the operator, using an ordinary thermometer in each gas off-take of the retorts. Often excess temperatures caused severe "capers" and "blows" with disastrous results to the workman, product and apparatus. After two years of experimenting, an automatic recording pyrometer, which withstood the chemical action, was completed and installed. There was centralized control, and one workman was enabled

to notify all other operators in advance of approaching high temperatures so that excess pressures were avoided and smooth distillations, with much less wear and tear in the apparatus, together with a 30 per cent. reduction in fuel, resulted.

The appliance was automatic to the extent that temperatures in all retorts were recorded every few minutes and a chart plotted, but it required the human brain to read and interpret those records so that the operators could be guided accordingly.

Of course the first cost of installation is often the tide against which the safety engineer has to paddle, but experience generally proves that the more automatic and centralized the control in chemical industry, the more economical is the operation in the long run. Fewer accidents, lower maintenance cost and few spills are really larger items. The first cost of installation is often saved by preventing a few personal injuries, damage to equipment and losses to product.

Good Housekeeping

We should not leave the subject of control without due regard for the great importance of good housekeeping and without reference to the human element. When we picture a dingy, dark, ill-lighted and poorly ventilated factory, such as we often see, is there any wonder that there are accidents? Accidents are a direct reaction of ill health, poor training, resulting in general indifference, or excess pressure set up in the chemical factory's nervous system—the workers.

Intelligent and well trained workers who enjoy healthful and cheerful working conditions, well lighted and ventilated buildings with interiors painted white, floors that drain, and apparatus that is tight and safe, are a great asset to the chemical manufacturer and should receive as much consideration as any other economic phase of his business.

In visiting many factories I have found those of fewest injuries, without any exception, to be those which are the neatest. The great moral effect upon the workers and the management, as well, is an investment that pays handsomely.

Maintenance and Inspection

Accidents resulting from pressures in excess of the strength of the apparatus often are caused by a lack of proper maintenance of the equipment, but are probably more often caused by lack of proper maintenance of the safety and control instruments.

It is difficult to separate inspection from any part of this plan, for inspection extends throughout all stages from designing and building to operating and maintaining the plant. Human acts should be based upon observation—the underlying principle of man's senses.

The plant manager is the chief inspector of the organization and although his obligation is great, the obligation of the safety engineer is relatively as important.

Regular systematic inspections of all apparatus by a competent and experienced operator, selected especially for this work, should be made. He should be a man capable of teaching other operators and inspiring them to co-operate by developing their interest so that they will make useful suggestions. Thus each worker, in a measure, would become a safety worker and not depend too strongly upon the safety engineer. On the contrary, the safety engineer must rely more upon the workers for the safe operation of the plant. By true and sincere effort on the safety engineer's part, and through freedom of suggestion and expression extended to the workers, a great advance in industry has been made in the past few years.

An International Language

An Appreciation of the Advantages to Science, Commerce and Literature of Esperanto as an Easily Acquired International Auxiliary Language.

By Rufus W. Powell

Secretary, National Association of Glue and Gelatin Manufacturers

IS it a dream or a vision? This is a question that has been in the minds of thinking men for years and many attempts have been made to solve it. To a people of more than 100,000,000, practically all of whom use English with only the most trifling differences, there has not seemed to be any necessity for the learning of other tongues. Even in the colleges there is a trend away from the study of the humanities and towards what can be applied directly to practical ends. It may be of interest, however, to see whether a tool, which, so far, has been mostly used by the idealists of this country, should be left so largely in their hands alone and neglected by the constructive forces of the United States. This should appeal to our scientists and particularly to our chemists.

A report is now being written of the proceedings of the Chemical Section of the International Esperanto Congress just held in Praha (Prague, in Chekoslovakia) and the scientists of Europe are taking up with avidity the study and use of a language which can be learned accurately in one quarter of the time that any national tongue can be learned imperfectly. The ordinary man will not usually care to give time to the study of anything for which he has no immediate use, any more than an ordinary boy would learn the multiplication table unless compelled; but there is no class of people who could learn Esperanto so easily, nor use it to such immediate advantage, as the chemists of the United States.

Its vocabulary is practically that of scientific words already in common international use and differing only in minor points. Anyone who sees the Esperanto words "telefono," "telegrafo," "skribmaŝino" would know instantly what they are, and practically the only mental effort required on the part of any scientist to understand and be understood by his confreres in any part of the world would be the acquisition of a few hundred connective words, the mastering of a grammar of sixteen rules, without exceptions or grammatical gender, and the throwing out of his mind of our confusing English idioms. There should be a particular appeal in Esperanto to those who wish to say exactly what they mean, which is the normal scientific mental attitude.

We have no idea on this side of the water of the way in which Esperanto is coming to the front in Europe during the last few months. Scientists there eagerly are taking hold of this effective means of international communication, and a very large proportion of the Esperanto journals of Europe which had to be suspended during the war are again being published, and the whole of Europe is being opened up sympathetically to the scientific world.

Esperanto is really a living language, having a literature of several thousand books or pamphlets and possesses already quite a number of advanced mathematical and scientific works. A language which enables better translations to be made into it from such rich vocabularies as those of the Greek, Latin, Sanskrit, Russian, French, Spanish, German, Persian and Arabic literatures, than into English is certainly ample and exact enough to express both the thought and facts so much appreciated by the scientific world.

The recent tariff hearings before the United States Senate are demonstrating to those who are wise enough to read them the fact that the time for our proud world isolation has passed away and that, without losing a proper sense of the value of our own nationality, we would be wise to place ourselves in sympathetic relations with people of other nationalities and histories. Viscount Bryce has shown in his recent book that, fine as are the English speaking democracies of the world, they are not the only peoples worthy to survive.

The trend towards a wholesome internationalism is shown by such action as that of the Paris Chamber of Commerce which urges the study of Esperanto by the commercial organizations of the world; by the fact that such conservative bodies as the Chamber of Commerce of London and the Chamber of Commerce of the State of New York give to Esperanto the same rank in their commercial examinations as given to any national language; that some European countries have lately made governmental subventions for the help of Esperanto courses of study; that in at least twelve important European, South American and Asiatic world centers, Esperanto groups called Common Commercial Language Committees have been formed to use this international auxiliary language for commercial purposes.

At the International Labor Congress in Washington there was an interpretation staff of over 100 persons. The British official interpreter at a recent Congress said that, if Esperanto had been used, the work would have been done in one-third of the time.

In the *Atlantic Monthly* for May, 1919, the famous Italian historian Ferrero in an article on "The Crisis of Western Civilization," in speaking of what took place in Paris in March and April, 1919, wrote in part as follows:

"I am almost tempted to say that during those two months I saw with my own eyes the confusion of tongues and dispersion of peoples actually come to pass in the very heart of Paris. Not until some later day shall we learn how many mistakes were made and how much time was lost by the representatives at Paris because they had not one, and only one, language with which all were familiar."

At the recent International Esperanto Congress held at Praha (Prague) there were 2,197 delegates representing 35 countries, but only four of these delegates were from the United States. This clearly indicates how far we are still behind the rest of the world in this important matter. News has come from Russia within a few days that the post office, telegraph, telephone, and radio telegraph officials of that country have taken hold of Esperanto with enthusiasm and have already formed 45 groups among these officials alone for the study of this international auxiliary language. Before the great war there were in Russia more than 300 Esperanto groups, largely composed of scientists and educators and these groups are now being revised and ought to be a great help in bringing that country again into harmony with the rest of the world.

Before the war there were more than 200 firms in one city in Germany using Esperanto for catalogues, price lists and international correspondence. The number of such letters and documents just now again being sent to known Esperantists in the United States indicates

that Germany intends to make full use of this effective means to recover as soon as possible the connections she temporarily lost during the war. These are but a very few examples among many of the way in which Europe is moving much faster than we are towards a new internationalism which is not opposed to a wholesome national development or emulation.

In his address when presented with the Willard Gibbs Medal by the Chicago Section of the American Chemical Society, Dr. Frederick G. Cottrell said:

"In his introductory remarks Dr. Whitney made reference to my interest in the problem of an international auxiliary language. Even here we have an interesting illustration of how prominent a part the physical scientist has played in international projects so far removed from his own direct field as the problem of language would seem to be.

"* * * * * it was among the members of the chemical group that the project first took shape to secure the appointment by the International Research Council of a committee 'to investigate and report to it the present status and possible outlook of the general problem of an international auxiliary language' and 'to co-operate in its studies with other organizations engaged in the same work'

"* * * * * 'What the scientist, and for that matter the business man and the man in the street, wants for international purposes is primarily not a literary language but a simple and serviceable code, bearing somewhat the same relation to the ordinary ideas of everyday life that the formulas of the chemist or the equations of the mathematician do to these specialists' own domains of thought. As a matter of fact, scientific terms are already practically international and so all that remains to be done is to bring the simpler and non-technical half of our concepts up to the same international standard of expression.

"Here, too, we must again emphasize the auxiliary character of such a proposed international code language, since it is in no wise intended to compete with any national language except for purely international purposes, where the only desiderata are simplicity, clearness and entire neutrality. Herein as a purely auxiliary tool it escapes completely from the type of opposition already discussed in connection with the compulsory adoption of the metric system.

"Few realize how much real progress has been made and how much tangible material as the basis for a critical study of the general problem already has been accumulated in this field. Thus at the outbreak of the war there were, for example, about a hundred journals being published in Esperanto alone and over half this number survived the cataclysm and are still appearing, with new ones being constantly added, especially from the newly created states, and suspended journals gradually resuming publication."

Since the utterance, May 21, 1920, of Dr. Cottrell's remarks, just quoted, the subject has taken more definite shape and it is now quite certain that a decision will be made within a year by an international governmental tribunal which will select a neutral (not a national) language for international auxiliary purposes. There are other languages than Esperanto striving for the honor but there is not even a good second in the field against it, as the nearest one has not one adherent to twenty followers of Esperanto, which latter has proved its adaptability in every way and is already successfully functioning, while all its rivals are simply academic projects.

In the meantime the International Research Council, with Dr. Cottrell as chairman of the Committee on International Language, is located at 1701 Massachusetts Avenue, Washington, with a very able linguist and business man, Mr. Ward Nichols, in charge, and any inquiries addressed to him will receive prompt and careful attention. Information may be obtained also from James F. Morton, Jr., secretary of the Common Commercial Language Committee, 211 W. 138th street, New York City; and probably also from the Bureau

of Standards at Washington, as quite a number of its staff are acquainted with Esperanto and fully prepared to use it.

To sum up—Is Esperanto a dream or a vision? Those who use it and have learned to love it, both for its usefulness and its beauty, feel sure that it is a vision which they have been fortunate enough to see somewhat in advance of others, and which they also wish to share with others who need it.

American Institute of Textile Chemists and Colorists

Following upon the preliminary organization meeting at the Chemists' Club in New York, September 13, of prominent textile chemists seeking to form a scientific and technical association within their own industry, at which a committee of five were appointed to submit working plans at the final organization meeting on the occasion of the Textile Exposition in Boston, 150 representative textile technologists met at the Engineers' Club in Boston on November 3 and effected permanent organization.

Professor Louis A. Olney, of the Lowell Textile School, was elected president; William D. Livermore, chief chemist, American Woolen Company, Lawrence, Mass., and William H. Cady, chief chemist, United States Finishing Company, Providence, R. I., vice-presidents; Walter E. Hadley, chief chemist, Clark Thread Company, Newark, N. J., secretary; Winthrop C. Durfee, consulting and manufacturing chemist, Boston, Mass., treasurer.

The executive council, which will govern the new association, comprises: George A. Moran, chief chemist, Pacific Mills, Lawrence, Mass.; Walter M. Scott, chief chemist, Cheney Brothers, South Manchester, Conn.; A. E. Hirst, chief chemist and assistant superintendent, American Printing Company, Fall River; Elmer C. Bertolet, professor of textile chemistry, Philadelphia Textile School; James L. Amsten, chemist, Rockland Finishing Company, Haverstraw, N. Y., and W. K. Robbins, Amoskeag Manufacturing Company, Manchester, N. H.

Local sections of the association are to be formed in the near future embracing the territory adjacent to Boston, New York and Philadelphia. Possibly one will also be formed in the South. The parent organization, however, is to be national and not local in any sense of the word. The governing council is authorized to arrange for co-operation with textile and color industries for the purpose of research and standardization of products and methods. This is in accordance with the objects of the organization, which were set forth in October CHEMICAL AGE.

Rules governing membership were approved at an evening session, providing for two classes or types, to be known as active and junior, the former to be at least twenty-six years of age and to be actively engaged as textile chemists, or in some branch of the application of dyes. Junior members would include students and apprentices, with the exception of charter members, who formed the nucleus of the organization today. All future active as well as junior members will be elected to membership by vote of the executive council.

H. B. Moore, formerly manager of the vegetable oil department of Chas. F. Garrigues Co., 54 Wall St., New York, and well known in the vegetable oil trade, is now with E. R. Smeade & Co., 2 Rector St., New York.

The New Chemistry Building at Cornell

THE week of October 20th at Cornell University witnessed the inauguration of Dr. Livingston Farrand, formerly president of the University of Colorado, as its fourth president in the half century of its existence, and the laying of the cornerstone of the new chemistry building, the gift of George F. Baker, chairman board of directors, First National Bank of New York, who in the midst of a notable gathering of educators and industrialists, participated in the ceremony.

Mr. Baker's benefactions to Cornell approximate \$2,000,000 and include in addition to the new chemistry building, the three residential halls known as Baker's Court and the financial aid that made possible the union of Cornell University Medical College and New York Hospital, whereby the Cornell University Medical College was enabled to take its place among the foremost institutions for medical education.

The chemistry building, which will be one of the largest and best equipped of its kind, will cost \$1,500,000 and will for the time represent the last word in design and facilities for chemical education. There are to be three full stories and attic, besides the ground floor above grade and a basement below. The building is of the shape of a hollow square of approximately 270 feet frontage by 200 feet deep.

An idea of the size may be gained by the fact that there will be about five acres of floor space, not counting the attic. The entire building will be as nearly fireproof as modern science can make it, and will be equipped with many safety devices.

The west and part of the north sides of the building will be flanked by a paved terrace, and a long flight of stone steps will lead to the main entrance. Entering by the main door the visitor would find himself in the main north and south corridor. Directly ahead will be a well equipped chemical museum about 45 by 60 feet.

To the right and at the south end of the building will be the general administrative offices, with the private office and adjacent laboratory of Prof. L. M. Dennis, the director of the chemical department. At the north end of the main corridor will be the chemical library and reading room, and across the corridor on either side of the museum a small lecture room.

The largest laboratory, that devoted to freshmen courses, will occupy practically all of the east side of the first floor of the building, and will be approximately 50 by 140 feet. It will be lighted from the east and court sides. This is to be devoted to introductory chemistry. The north side of the first floor is devoted to advanced inorganic chemistry including the faculty offices and laboratories. The south portion will be devoted to inorganic research.

The ground floor may be reached from the first floor main entrance or by separate entrance at the north end of the main corridor—also by small doors at the east ends of the north and south corridors.

Under the west side, to the south of the entrance, will be the storage battery plant for the entire building, special research rooms, and a bomb room. The corresponding rooms at the north of the center are motor generator rooms and for other electrical equipment. In general the eastern portion under the laboratories will be given up to the storage of chemicals and apparatus. The rooms on the north side will be for industrial processes and will connect directly with the industrial laboratories on the ground floor.

On the second floor will be a general auditorium with balcony, seating 500. The main laboratories on this floor will occupy the entire east block and are for organic chemistry and quantitative work. Flanking these to the north, and occupying the north side and half of the west, will be the more advanced laboratories. The south portion will be devoted to organic research, together with offices, etc.

The central portion of the third floor will be occupied by the balcony of the auditorium. The laboratories on the west side will be smaller than those below, but systematically arranged, the north half being devoted to sanitary chemistry and bacteriology, and the south half to agricultural chemistry.

One of the most interesting groups in the entire building occupies the north portion and half of the west side of this floor and includes chemical microscopy, photomicrography, metallography, optical research, spectroscopy, etc. There will be a mezzanine office directly over the west entrance to house the chemical editorial rooms.

An interesting feature of the plan is the continuous corridor arrangement around the north, west and south sides of the building, in addition to the main corridor at the west entrance.

All supplies will be delivered to the building at the interior court and transferred directly to the stock room in the east wing. At both the north and south ends of this general storage room will be elevators serving all floors.

The question of laboratory ventilation was the subject of exhaustive research on the part of Professor Dennis and the architects. The result is believed to be the most perfect system of hood exhausts in operation in any chemical laboratory. The laboratory floors will be made of a special asphalt mastic.

The principal laboratories are to be equipped with showers so that in case of accident the victim may be placed under a shower at a moment's notice and the danger from acid burns reduced. An emergency room is also provided on each floor, convenient to the principal laboratories, as well as rest rooms for the women and a lounge room for the men.

Practically every laboratory table will be equipped with hot and cold water, compressed air and gas, as well as many with alternating and direct currents, and a few with oxygen and other special gases. All the hoods and



GEORGE F. BAKER

Chairman, First National Bank, New York
Donor of Cornell's New Chemistry Building



Associate Architects:
Gibbs & Waltz, Ithaca, N. Y.
Day & Klauder, Philadelphia, Pa.

John C. Westervelt, B.S.A., Cornell '94
New York City.
Chairman, Committee on Buildings and Grounds.

View of New Chemistry Building in Process of Construction at Cornell University.

a few tables are to be equipped with live steam.

The building will be heated by a direct radiation vacuum steam system, but an auxiliary supply will be furnished with tempered air as a part of the ventilating system.

This laboratory has made such strides in advance of those already existing that it has been the subject of

numerous inquiries, and many points worked out especially for this building will be made use of in plans for new laboratories for Yale and Columbia universities.

The contract calls for the completion of the building 100 weeks from the time the ground was broken, last July, and it is now planned to build the ground floor and the first floor, if possible, this fall.

The Status of Lubrication Engineering

By W. H. Bailey

Chief Engineer, Illinois Steel Co.

ONE of the great problems of vital importance confronting the industrial world today, and in particular the industries of our own country, has to do with the conservation of lubricants and liquid fuels, and the bases from which these commodities are derived. The bases for the lubricants are of three distinct orders, mineral, animal and vegetable, and of the liquid fuels, mineral and vegetable. Of these the mineral bases furnish the greatest preponderance of products of both liquid fuels and lubricants; of the mineral bases petroleum is by far the most important.

The necessity for conserving the bases for our lubricant and liquid fuel supply, and in particular the natural petroleum reserves, is a matter of absolute necessity if we are to continue to maintain our national industrial supremacy. It is common knowledge, being of such a nature as to appear frequently in the public press, that petroleum is the subject of great national movements and developments. In fact, so great is the necessity of owning vast reserves that foreign governments, keenly alive to the situation, are becoming financially interested and in instances are taking an active part in the control and management of their petroleum supplies, manufacture and distribution.

The present extravagant rate of consumption makes it necessary to sound repeated warnings that the commercial exhaustion of our supplies is already in sight. It is true that new fields will be developed and even fields of the first magnitude may be discovered in the United States or her territories, the very existence of which may not even be suspected today by geologists.

At best, however, this would defer the end that is in sight but a relatively short time. Neither can one take great comfort from the fact that in our western country there exists literally mountains of rich oil-

bearing shale; because these deposits will require, for their commercial working, an industry paralleling our present coal industry in addition to the forces employed by the oil industry, so that methods of recovery will have to be developed that are cheaper and more practical than any known to science today, or the cost of the product of the shale will be so great, as compared to natural petroleum products, as to be exceedingly burdensome.

The use of lubricants is universal. Every steamship, every railroad train, every piece of machinery in every industrial plant is vitally dependent upon lubricants in some form. Without lubrication the wheels that produce our food on the farms, that carry it to market, and all of the activities that have to do with our modern civilization, would stop and our processes would have to revert to those of the time when animal power was responsible for the things we do now by machinery.

Waste of Lubricants

The greatest waste of petroleum products today is, unfortunately, the most valuable and costly derivative of petroleum, the lubricants. This waste takes place in all of the industries and comes about largely through a lamentable lack of sound practical as well as scientific knowledge on the subject of the application of lubricants, the selection of the best form and grade of lubricant for specific purposes, of methods of handling and reclamation, and of proper bearing metals and mediums.

There is another source of loss in the present wasteful use of liquid fuel and lubricants in our ten million internal combustion engines, working on fuels for which the engine was not originally designed and as a consequence now operating in an unbalanced con-

dition as to rust and lubricant. This has developed what is known as the dilution problem, which will account for immense losses of fuels and lubricants, as well as depreciation of equipment. There is also in an astonishing number of cases throughout the industrial world a complete indifference to the proper methods of handling and storing as well as the mechanical application of lubricants and fuels.

The Need of Scientific Knowledge

While scientific lubrication is one of the most important branches of engineering, it is also one of the most neglected. It is safe to say that not 10 per cent. of the users of lubricants have made any extensive attempt to determine scientifically the best form and grade of lubricants to use for the specific purposes required in their shops or upon their machinery. About the most they know about or care to inform themselves about is that a certain brand of lubricant is sufficiently satisfactory to allow them to get by without any great loss. They are utterly without technical knowledge of why this particular brand of lubricant gives better service than other brands they have applied for the same work.

It is also questionable if more than a small proportion even of the users of lubricants are aware that lubricating oil is practically indestructible if kept purified and free from dilution, and that in most cases used oils may have their original properties completely restored, and in many cases actually improved at only a fraction of the first cost by proper methods of reclamation.

There are a few scientific minds giving their earnest attention to the problems in question and there are a great many engineers and practical operators who realize the importance and possibilities involved and who, as individuals, are striving to better the deplorable conditions that prevail. There is, however, today no organized general attempt towards betterment.

The reason for this is that there has been no general medium for the exchange of scientific and practical ideas on the subjects of lubrication, its application, conservation and reclamation and with the subject of the scientific application of liquid fuel. Neither is there any institution of learning in the United States that has a course of study devoted to these subjects.

Every dollar's worth of lubricant used by the industries should be purchased with a definite knowledge of the form and grade of lubricant best suited for the work that must be done. As a matter of fact it is altogether common to find an extreme difference in the grade of lubricants used for identical purposes by two manufacturing plants within a stone's throw of each other. One may be using the highest grade of lubricant available and his neighbor the cheapest that comes from a refinery and both lubricants will often be unsuited to the particular service in which it is applied.

In one case the lubricant, although of high quality, may be too light or too heavy for the work and far more expensive than a grade suited for the purpose. The other case will require an exorbitant amount of the lubricant to prevent burning out bearings, costly wear and tear of expensive machinery, and so on. In each case a little sound advice and a knowledge of the best means of application would effect large savings.

How can the general user obtain a more definite knowledge of the properties required of his lubricants

to best serve his purpose beyond ordinary means of observation unless there is some medium through which he can obtain this information, or which will keep him advised of the practical and scientific findings of those engaged in research work along this line or of the experience and practical observation of operators in lines similar to his? There are no comprehensive text books on the subject, or until recently were there any publications devoted to it, or was any society or organization giving its effort to the subject with the avowed intention of developing the art of application of lubricants and liquid fuels.

American Society of Lubrication Engineers

Last Fall, in Chicago, there met a small group of technical men whose lives have been devoted largely to the problems related to the scientific application, conservation and reclamation of lubricants and liquid fuels. With a full realization of the urgent necessity of an organization to bring about a betterment and a general understanding of the fundamentals of these subjects, they organized the American Society of Lubrication Engineers.

The prime object of the society is educational. The desire is, in effect, to establish a general clearing house for the interchange of technical ideas and the presentation of technical data relative to the scientific application, conservation and reclamation and handling of lubricants and liquid fuels. This is to be accomplished through bringing together those interested in those subjects through divisional and general meetings and through the society journal.

The first annual meeting of the society was held in Chicago, October 12-13, under such conditions of attendance and interest in its field of work as are most gratifying. The American Society of Lubrication Engineers has undertaken a great work. It has a definite duty to perform; a vital message to the whole industrial world; a broad patriotic object to accomplish. It will bend every effort to arrive at the fulfillment of its purpose.

Chemical Warfare Service School

Controversy over the functions of the chemical warfare service of the army, and over the training of troops in chemical warfare, which existed between that service and the departmental regime under Secretary Baker and General March, has been terminated by recent orders of the War Department relating to the training of troops in that kind of offensive and defensive warfare. Under the former regime it apparently was sought to curtail chemical warfare developments and training as much as possible. Now the fullest co-operation appears to exist between Secretary Weeks, General Fries, chief of the chemical warfare service, and Generals Pershing and Harbord.

In accordance with the new order, the special school of the chemical warfare service at Edgewood Arsenal, Md., will be conducted for training and instruction of officers and non-commissioned officers both in offensive and defensive phases of chemical warfare.

Our presentation in October, 1921, *CHEMICAL AGE*, page 403, of the specifications of U. S. Letters Patent No. 1,384,566, on an "Improvement in Contact Process of Sulphuric Acid Manufacture," issued July 12, 1921, to Henry J. Merriam and by him assigned to the General Chemical Co., did not meet with the approval of this company inasmuch as the patent involved the work of many men and its publication might in the form there appearing introduce misunderstanding.

American Institute of Chemistry

IT is estimated that there are about 20,000 chemists in America, which is but a small part of those identified with chemically controlled enterprise. The present year has witnessed a demand for chemical education that taxes facilities of instruction. The increasing number of the chemical novitiates of industry should not be considered as so much "kanonenfutter" for the "chemical machine," but rather as calling urgently for organized study that the efficiency of their production, i. e., the quality of the technical recruits of industry, on the one hand, may be improved, and, on the other, that their absorption by industry may be effected with the least waste.

These are professional problems, distinctively economic in their character, and can be worked out progressively only by individual reaction to environment, and hence are local, community problems, in the solution of which chemically educated men and women show their primary responsibility as citizens to their respective locales and not to a remote hierarchy with headquarters in New York.

There is no group among those denominated the technical professions whose body of membership needs more the cultivation of professional consciousness than do the educated chemical workers. This can not be done by any group, clique or coterie that in the conceit of power born of the acquiescence of indifference, would presume to do the thinking for the mass.

It can be done only by the men themselves on the spot in such service to the community, and hence to themselves, as the community rightly expects of its educated members. To neglect this logical service in a field so intimately related to community welfare as chemistry, not only inspires community indifference to chemists as a class, but "sets" in the character of the chemist as an individual that aloofness, social backwardness, indifference to class and general welfare that characterize generally men who have not got the faculty of mixing with their fellows.

We would not disparage in the slightest degree the magnificent educational service of the American Chemical Society, or the vision and sacrifice of the many men who have made it possible, or advocate a policy that would hamper it. We do, however, deplore a callousness to the stimuli of conditions that, in the face of the numberless precedents of history, surely will eventuate this possibility.

The American Chemical Society declined to send a delegate to the foreign Trade Council on the ground that it is not a trade organization, but it has become in the ramifications and affiliations of its management, in addition to its primary function of the advancement of chemical science, a secret society, a commercial organization, a board of strategy in chemical politics, a propaganda bureau—all purposes largely commendable in the desire to promote chemical enterprise in America, but nevertheless a melange that has not precedent or parallel in any organization of technical men in America.

Do mechanical engineers, trained nurses, civil engineers, plumbers, mining engineers, lawyers, accountants, electrical engineers, veterinarians, teachers, chemical engineers, doctors, clergymen, dentists or architects permit their respective technical or scientific organizations to become a tail to the kite of the corresponding commercial interests?

We do not condemn such activity *per se* of the American Chemical Society. What we do deplore and con-

demn is the obliquity of the management active in control of the society in their discouragement, disapproval and condemnation of any exercise of the instinct of segregation, independent of its auspices, in its manifest policy of monopolization of all intellectual enterprise in chemistry and its resort to the methods of ward politics to injure those who openly do not agree with it.

What we are concerned with here is the economic organization of chemists on state lines, whereby chemists themselves may work out their own destiny in the solution of problems peculiar to their locale. Such procedure involves no sacrifice of loyalty to the scientific and educational activities of the American Chemical Society which merit the praise of all men, but it does involve the right of the educated chemical workers in industry to inculcate professional standards and to study their material problems free from the interference and domination of those who think such organization superfluous and duplicative and that they are the ones duly anointed to do their thinking for them.

Inasmuch as chemists' responsibilities as citizens primarily are to their communities, economic organization on state lines is as natural as any process in biology which has efficiency for its unconscious aim. The obese structure of the organization to which we all belong is distinctly Teutonic in plan, and functions on all-fours with the political anachronism now defeated, discredited but still defiant. The contra-distinction of feudalism and democracy lies in the respective principles of "all for one and one for all," and "all for each and each for all."

Students of technical organization in America are familiar with the origin of the American Association of Engineers in revolt of a conservatism that lagged behind the times and of its growth in a decade to the largest and most virile organization of technical men in the world.

What is demanded today in organization of chemically educated workers is material service to members. This is not practicable in an organization controlled by interests that do not desire such organization.

That the American Institute of Chemical Engineers is eminently proper is eloquent either of the opinion of the "bosses" of the American Chemical Society as to the inferior capacity of American chemists to do anything for themselves, or of a determination not to permit them to try it, or of a profound conviction that they are the keepers of the American chemical conscience and alone know what is good for American chemists.

It should bid us pause that there is such a situation that only the most courageous will speak openly the thoughts of a great body of American chemists; whereupon flow from Boston and Gloucester and Savannah to Los Angeles and Seattle commendation and congratulation that someone else has said it and not they themselves.

A local branch, under the leadership of Charles B. Hall, sales manager, chemical department, Cleveland-Cliffs Iron Co., of the National Association of Chemical Salesmen, has been formed at Cleveland, Ohio.

A new ceramic laboratory, in which investigative work regarding the clays of the Northwest will be conducted, is to be installed at the Northwest Experiment Station of the United States Bureau of Mines on the campus of the University of Washington at Seattle.

Synthetic Organic Chemistry Our National Salvation

By George D. McDonald

AMERICA stands today at the parting of the industrial ways. The next two years will decide whether she is to become the greatest of all industrial nations, utilizing her illimitable resources to their fullest extent, making the widest use of her unrivalled capacity for technical development, reducing her manufacturing wastes and converting her by-products into commercial assets; or whether she will complete her destiny in dependence on the research undertakings of other nations, adapting the discoveries and processes of the old world to her growing needs.

We are living in a CHEMICAL AGE, and nine-tenths of our industrial activities are dependent, directly or indirectly on chemical research. That nation which has a well-developed chemical industry lending its technical aid to every branch of industrial enterprise and which is producing an unfailing supply of those trained investigators who are indispensable to all branches of modern manufacturing, is the one which will retain its position in the front rank of progressive peoples, and in so far as it leads in chemical expertness and inventiveness will control the industrial destinies of the world in the next fifty years.

That is the task which Germany has set herself, to the attainment of which she is straining every nerve. While the other nations still waste their substance in the building and maintenance of vast armies and navies, while their peoples are still staggering hopelessly under ever-growing and insupportable burdens of taxation for the upkeep of these non-productive expenditures, Germany herself under the necessity of paying \$33,000,000,000 to the rest of the world, as a recognition of her responsibility for the war, is settling down to earnest work, and to the attainment of her ambition—temporarily delayed by the madness of her military class—to dominate the industrial destinies of mankind. Charles M. Schwab has said "that of all European countries involved in the World War, Germany will be the first to regain industrial stability."

Up to comparatively recent times the world has been going through the period of analysis; like the curious enterprising boy we have been pulling the watch to pieces to find out how it was made. The era of analysis is passing; that of synthesis is at hand.

Hitherto the chemical activities of this country have been largely analytical; today they must of necessity be synthetic. Our chemical knowledge must be applied to the producing of new products. Synthetic rubber, synthetic camphor, synthetic dyestuffs, synthetic tanning materials, synthetic medicinals and scores of other products duplicating the slowly yielded gifts of nature, are now demanded by the intense necessities of human life.

For the last fifty years this particular phase of chemical achievement has been the peculiar possession of Germany and she has so impressed the mind of the world with her chemical ability, that it has been very generally assumed that she was unapproachable in this branch of science, and was the discoverer and originator of practically all the fundamental principles on which modern chemistry is based. As a matter of fact, Germany has but few basic discoveries to her credit. Of the twenty-one fundamental laws generally accepted as governing this science not one is attributable to German science. The scrutiny of any reliable history of chemistry discloses the fact that there are French, English, Belgian,

American, Dutch and Italian names to be found there as identified with chemical discovery, and but few German names.

The public sees only results; it has no conception of the vast work necessarily undertaken by research chemists to attain these results. It has been the inability to impress this fact upon the mind of Congress during the past few months in the effort to obtain recognition of the vital necessity for protection of the chemical industry, which has been the most discouraging feature of the situation.

The fortuitous circumstances of the war forced America to graduate from the academic character of her chemical knowledge and equipment into one of constructive adequacy. Those plants which existed prior to 1914 were compelled to extend immensely their activities and to undertake research and to organize phases of manufacture which had, prior to that time, been simply matters of academic interest.

Vast new enterprises were undertaken, hundreds of millions were invested in chemical plants and laboratories, and this country came to be in the short space of four years, a potential rival of Germany in the applications of chemical knowledge.

The public does not understand the stupendous difficulties and enormous costs which are inseparable from this chemical development. Processes and plants installed today become obsolete tomorrow and have to make way for new processes and plants as technical knowledge and experience is enlarged, these again calling for huge expenditures. The slow and expensive methods whereby chemical knowledge thus obtained is applied to the problems involved call for unlimited patience and unhurried time. An almost endless succession of preparatory steps must be taken to reach a desired end. The production of the raw materials necessary for the creation of the finished products must be undertaken and standardized, the principles of chemical control devised and the necessary labor trained to conduct large scale operations which become essential before commercial success is attained.

The cost of all this does not show in the finished result, but it necessarily must be amortized in the sales value of the finished article. It is a problem which differs from those experienced in any other activity and involves expenditures which are not imposed on any other industry. Problems which confront the textile manufacturer are simplicity itself, compared with those which the industrial chemist has to meet every day of his life. Given the correct analysis of a yarn or a fabric, the simple adjustment of well-known mechanical appliances only is necessary in order to produce the required result, and the production of the finished article is largely a matter of correct speeds and properly adjusted gears, and is not subject to the thousand and one unexpected contingencies and unforeseen reactions which a coupling of chemical steps involves.

The training of research and manufacturing chemists which has had to be undertaken collaterally with the development of the industry, under conditions of high pressure, is probably the most important industrial necessity confronting us today. The raw material for these young chemists is supplied by our universities and textile schools, but even under the most favorable circumstances, it is only raw material.

Under the pressure of the demand for chemists, not

only from private interests but from the Government itself, our institutions are meeting the situation with exemplary energy, and many millions of dollars are being devoted to the extensions of the collegiate chemical courses throughout the country.

The strength of Germany has been in her vast equipment of research laboratories connected with the coal tar chemical industry. Here it is that an ambitious youth may come, inspired by some aptitude for chemistry, with the knowledge that he will be systematically guided and encouraged, supplied with appliances and materials, paid for his time and efforts, and his academic preparation gained in the gymnasium and technical schools crystallized into commercial values. At the end of two years of practical intensive training, if his efforts prove to have a value, he is guided into that particular industrial avenue where his services and his training can be of the greatest and most immediate use. It may be in the utilization of by-products from coal tar; it may be in the manufacture of rubber, of steel, of sugar, leather, coal or paper; but wherever there is a need for his services, that is the direction in which he is judiciously directed. The coal tar chemical industry is the super-university where, and where alone, these research chemists can be trained. The possibilities in the distillation of coal tar are only beginning to be unfolded in this country; the mere production of coloring matters is one of the less important of the results possible of attainment.

Compared, for instance, with the production of pharmaceuticals the coal tar dye industry is insignificant. The total sales of dyestuffs in this country in 1913, the last normal year of happy memory of which we have knowledge, both domestic and imported, was only \$25,000,000.

The total expenditure for pharmaceuticals and drugs in the same period was upwards of \$500,000,000. It is from the coal tar chemical industry that those drugs are obtained which are universally recognized as being among the greatest of boons to suffering humanity. Who can measure the relief from the bondage of pain and fear that has been conferred by the knowledge we have acquired through research, of the healing and alleviative qualities of aspirin, phenacetin, novocain, procain, adreniline, veronal and many other coal tar derivatives which now hold honored and unassailable places in the universal pharmacopoeia? What incalculable benefits have been conferred on sorrowing and saddened multitudes by the discovery, through research, that luminal, the only known alleviative for epilepsy heretofore obtained with difficulty and in limited quantities from the virus of bees, can be secured synthetically from coal tar so easily and cheaply, that from four pounds of tar is secured as much as formerly required the glands of 4,000 bees.

Dr. Caleb Layton, member of Congress from Delaware, said in his eloquent speech in behalf of the embargo provision of the Fordney Tariff Bill, in speaking of the discovering of suprenen, now an indispensable factor in bloodless surgery: "When it is understood that it takes the glands of 30,000 sheep to make a pound of suprenen, one gets a competent idea of the saving value of synthetic chemistry."

But not only in the realm of pharmaceuticals is synthetic organic chemistry of indispensable utility in our daily lives. It enters into the preparation of our food as well as in relation to everything we wear, buy and use. Apart from the coloring matters in our textile fabrics, there is no article of use or adornment which

does not in some form or other use the resultant products of the coal tar chemical industry.

The work of the research chemist is constantly tending towards the improvement of our conditions of living, the increase of our creature comforts or for the alleviation of our suffering. These are the direct uses of the organic chemical industry. Even still more valuable and indispensable are its indirect uses.

The question of the fertilization of the lands now becoming a matter of the most urgent importance as our population grows, and our inhabited areas extend, is indissolubly allied to chemical investigation. This again is a matter which the infinite chemical patience of the Germans has developed to an extent where it is today an essential factor in human life.

The fixation of nitrogen from the air, and the resultant ammonia and fertilizing nitrates; replacing the rapidly depleted natural deposits found in various parts of the world is now a matter of national necessity. The country which can replenish its land values and obtain the largest possible yields from its agricultural activities, becomes at once in a position not only to supply the ordinary needs of its population but to meet the sudden and urgent demands which may be created in the future by such a dislocation of the economic conditions as confronted us during the four years of war.

This again is a matter of research, infinite, ceaseless research, and again is this research only possible from a self-contained, thoroughly entrenched, and adequately protected chemical industry. The use of coal tar chemicals in the production of explosives and poison gases has been sufficiently set forth, and it is a phase of the industry which must not be lost sight of. It is within the memory of all of us, that the condition of unpreparedness in which both Great Britain and the United States were found at the outbreak of the great war, brought us to within measurable distance of military subjection. For three years the fate of the world hung in the balance, and at more than one critical period a feeling of hopeless conviction pervaded both these great industrial nations, that the judgment of Germany's military commanders was being justified and that the glory of Anglo-Saxon supremacy was waning.

The contention has been made by some of the opponents of the plan for the protection of our organic chemical industry, that we have nothing to fear from Germany, that the expropriation of a large proportion of her coal supply has nullified her ambitious intentions, and that she is not economically in a position to dominate the rest of the world.

There is one factor, however, of which these opponents are ignorant, and which alone will place Germany in a more commanding position than she has ever heretofore occupied.

Germany has limitless deposits of brown coal or, as it is known in this country, lignite. Up to the necessitous conditions created by the world war, neither Germany nor we had ever utilized these brown coal deposits further than for the manufacture of briquettes made by drying and pulverizing the brown coal, mixing with bituminous dust, and associating the result with a binder so that it should be in a condition to mould and consolidate.

Quietly, however, Germany has been conducting with her characteristic thoroughness intensive research into the utilization of this brown coal, and today she can obtain from it by distillation practically all of the products which she heretofore obtained from the distillation of coal itself. She is within measurable distance of being independent of the coal deposits of the Saar

Valley and the Silesian coal fields; she is almost in a position to snap her fingers in the face of the Allies and to tell them that they can make such disposition of her deposits as they like; that she has sources of supply independent of bituminous or anthracite coal, and has in her organic chemical industry a potential source of supply of coal tar derivatives entirely dissociated from the controlling conditions of the Peace Treaty.

This instrument compels her to deliver annually to France for three years, 50,000 tons of tar, 35,000 tons of benzene, and 30,000 tons of ammonia, and with an astonishing lack of prevision and knowledge, it was actually stipulated that the tar should be produced from ordinary black coal. No doubt the framers of the Treaty thought that in making this stipulation they were hobbling one of the most important of Germany's industrial possibilities; as a matter of fact, they were playing directly into her hands and nothing could have suited her intentions better.

Such is the meaning of the organic chemical indus-

try to this country, and particularly the coal tar chemical industry on which such a vast proportion of our industrial and chemical life depends, and yet it is being disputed in Washington on a basis of the most trivial, petty politics and selfish interests.

It is not a question whether a few selfish manufacturers should obtain their dyestuffs at a few cents a pound less than they properly have been assessed as an accompanying need for the amortization of the vast research expense already undertaken; it is not a question of whether a politician from one part of the country shall subserve the interests of a limited portion of his constituents; it is not a question whether the conjured spectacle of a monopoly which has no existence, and which cannot have an existence in fact, shall be especially favored, but it is a vital and essential question striking at the very foundation of our continued national prosperity and safety, and should be judged on the basis of the ultimate welfare of the people of this country as a whole.

The Stamford Chemical Society

THE origin and growth of the Stamford, Connecticut, Chemical Society and the determination of its members to make it a constructive influence in a New England industrial community are notable because it constitutes an expression of a growing conviction among American chemists that making good solely as an industrial worker is only a part of the social responsibilities of the chemically educated man. Chemists rapidly are coming to realize that the scientific organization can not provide all the stimuli needed to develop their potentialities of usefulness and that it is unwise to thrust upon it responsibilities for which it is not intended or adapted, but that if they are to make anything out of themselves outside of the plant, it should and must be through independent initiative in service as citizens to their communities, whereby they may grow up to the respect that they inspire.

The Stamford Chemical Society embodies in embryo the American Institute of Chemistry in that it represents economic organization on community lines whereby chemically educated men gather together, not primarily as a mutual admiration, paper-reading group, but from a sense of responsibility to the community and to their fellows, whereby they may grow on the one hand in service to the community and on the other in service to the group. The former aspect of this type of organization is altruistic; the latter aspect is that of egoistic discrimination which is the basis of purely professional organization adapted to local industrial conditions. The fundamental principle of this type of organization is self-help and rivalry in help to others.

The geography of Connecticut does not permit the type of independent organization that has been so successful in New Jersey. In the latter State Newark is the metropolis with an accessibility which favors a central organization. Chemically controlled enterprise in Connecticut is scattered chiefly in the larger cities of Stamford, Bridgeport, New Haven, Hartford, Ansonia, etc. Under these conditions local chapters or community chemical societies will provide opportunity for chemists to acquire experience in work of organization, all readily co-ordinated in practical operation, whereby not only is there rivalry in service to

their respective communities, but with an organic connection that permits the freest intercourse in ideas and individual service.

The Stamford Chemical Society had its origin in the inconvenience and expense of attendance at chemical meetings in New York. The founder and first president (1919-20) was Dr. Frederick H. Getman, formerly professor of physical chemistry, Johns Hopkins, author of "Outlines of Theoretical Chemistry," and a contributor to current scientific chemical literature. Dr. G. C. Given, of the staff of Richards & Co. (Atlas Powder Co.), was president in 1920-21. Present officers comprise S. D. Shipley, director of research laboratory, Richards & Co., president; E. H. Smith, director, Science Department, Stamford High School, vice-president; F. B. Wilson, chemist, Atlantic Insulated Wire & Cable Co., secretary; R. E. Hicks, chemist, Yale & Towne Mfg. Co., treasurer. The members of the executive committee comprise, in addition to the above officers, Dr. Frederick H. Getman, research chemist; R. H. Stevens, research chemist, J. H. Wallace & Co.; Roy H. Wisdom, supt., Stamford Dyewood Co., and Kingsley Gillespie, of the Stamford Advocate.

All meetings are held at the Stamford High School, where, in addition to those of members, addresses have been made by Dr. Harlan S. Minor, Welsbach Light Co.; Dr. Harold Hibbert, department of chemistry, Yale University; Dr. George K. Falk, research chemist, New York, and others. The first public meeting of 1921-22 was held October 24th, when Dr. Getman addressed the society and guests on the scientific aspects and technical applications of radium. Arnold M. Taylor, of Richards & Co., discussed the new selenium method of making sulphuric acid, and F. B. Wilson, secretary, accelerators in rubber vulcanization. At the next public meeting, November 28th, E. P. Stevenson, of Arthur D. Little, Inc., will attend.

Citizens of Stamford are urged to become members of the society, for it is through the sympathy of those interested in the science and art of chemistry that chemically educated men sell their profession and themselves to the community and so make chemistry a constructive force in community progress.



Delivering Zirconium and Titanium Ores to the Concentration Plant, Mineral City, Florida.

American Production of Zirconium and Titanium Ores

LITTLE has been written or disclosed regarding the potential supply of zirconium and titanium ores in the United States. Old data concerning passé deposits in North Carolina still crop into print; California, Colorado, New York and Oklahoma lay claim to deposits of these minerals, but these are of minor importance in so far as commercially available quantities are concerned, and are of value mostly from an academic standpoint.

Zirconium and titanium ores are very widely distributed, being found in many localities of the United States, but seldom in large deposits where they can be profitably worked. Scientists have very carefully calculated that one-twentieth of the Earth's crust is composed of titanium. Zircon, the silicate of zirconium, is very often an associate of this mineral.



Mining Zirconium and Titanium Ores in Florida

In the light of data concerning every known deposit, it is believed that Florida contains the largest commercial deposit of these minerals. This statement is based upon facts concerning present and future ore supplies, methods of mining, cost of production, transportation facilities, economical treatment of the ores owing to their fineness and purity, and especially because of the fact that this deposit has been and is now being successfully worked on a large commercial scale. Furthermore, the associated minerals make feasible the successful operation, whereas other deposits not having such helpful revenues are at a disadvantage. The Florida deposit has no overburden, requires no crushing of the ores and one of the largest artesian wells in the world supplies more than 2,000 gallons of water per minute, making possible such an enterprise. The Florida climate permits cheap mill construction and daily production.

This deposit is about 27 miles from Jacksonville in a southeasterly direction in St. John and Duval counties. It is accessible by motorcar via the Atlantic Beach brick-paved boulevard from Jacksonville to the ocean, thence southward via the hard beach to four miles south of

Pablo Beach. This ride is a rare treat, the beach being at low tide, over 400 feet wide and almost as hard and smooth as cement. At the plant, a city has sprung up and is now a listed post office—Mineral City.

Mineral City, Florida, is composed of many attractive cottages for the white population. Some of these are built near the beach, while others are inland about one-quarter of a mile. The large and far-spreading concentration plant covering several acres, is inland above one-quarter ($\frac{1}{4}$) of a mile and is connected with Pablo Beach by the operator's five-mile standard gauge railroad which makes a junction with the Florida East Coast Railroad. Back of the plant, there are a great many houses of better than usual quality, for the colored help.

The deposit, many miles in extent, is owned by Buckman & Pritchard, Inc., New York. The machinery used in the complex separation scheme is almost wholly of original design, methods of separation being unique, as this plant is the only one of its kind in the world. Some idea, however, can be gained as to the magnitude of operation when it is realized that over 500 tons of ore are delivered daily to the mill for separation. New equipment is now being installed so as to double this capacity.

The principal ores mined and their uses are:

Ilmenite—A titanate of iron from which ferro-carbon titanium is made in huge electric furnaces at Niagara Falls. From this also is made a new pure white paint pigment having twice the covering power of white lead. Several titanium compounds are used for tanning leather and dyeing textiles.

Zircon—The silicate of zirconium is next in abundance and perhaps of the most importance. From it wonderful refractories, bricks, crucibles, muffles and refractory cements are being made. This material when pure, melts about 4,000° Fah. and is not attacked by many of the worst slags which destroy all other refractories. It also is used as a substitute for tin oxide and zirconium oxide in vitrified enamels. As a valuable material in the manufacture of electrical porcelains, spark plug porcelains, pyrometer tubes, laboratory ware, etc., its proper incorporation into the clay mixture imparts increased mechanical strength, greater resistance to high tension current at high temperatures, greater resistance to temperature shocks and immunity from attacks by acids and alkalis.

Zircon is truly a wonderful mineral, being unaffected by acids and alkalis at ordinary temperatures and having permanent volume, that is to say, it neither shrinks or swells under terrific heat. It is the mystery mineral. Basic patents have been granted to Henry H. Buckman and George A. Pritchard for the use of zircon in refractories and electrical porcelains, as set forth in U. S. Letters Patent Nos. 1,370,276 and 1,375,077.

Safe Practice in Handling Sulphuric Acid

By M. F. Crass

Chairman, Accident Committee, The Grasselli Chemical Company

IT is generally recognized among acid men that the venting or unloading of acid tanks is more safely accomplished by the blowing method than by any other. By the application of 30 pounds air pressure, acid can be lifted to a height of 40 feet, which is ample in most cases to discharge easily the contents of the tank car into an elevated storage tank. This method is economical for it entails little expense other than the maintenance of a small air compressor. On the other hand, if the tank car is equipped with a bottom outlet, it is necessary (unless your loading track is elevated) to discharge the consignment by means of an acid pump—a more expensive proceeding, for the maintenance expense of an acid pump is considerable.*

Tank Car Bottom Outlets

The greater the simplicity of any chemical apparatus, the more desirable it is, provided efficiency is not sacrificed.

Colonel Dunn, Chairman of the Bureau of Explosives, in a recent article strongly emphasized the fact that the breakage of the outlet connection frequently follows a derailment and adds considerably to the property damage and loss.

Bottom outlets are subject to considerable wear and tear and the threads of the collar which holds the plug or outlet cock are weakened by action of the acid. If bottom outlets were necessary for the discharge of the tank car consignments, they might be considered a hazard incident to the use of such equipment. This, however, is not the case. Experience has shown that the safest and most convenient method of discharging tank cars—that of discharging by means of compressed air—leaves no room for doubt as to the type of equipment or method which should be used in discharging acid from tank cars.

Amount of Acid Loaded in Tank Cars

This is an important matter, the danger of which is not always appreciated. Variations in atmospheric temperature, especially in hot summer periods, tend to increase the volume of the acid through expansion. There is also further possibility of generation of hydrogen gas which directly concerns the amount of acid which should be loaded in the tank car because of the space which it takes up when present.

The Bureau of Explosives covers this point in B. E. Pamphlet No. 9, paragraph 1825-A, wherein it is provided that the vacant space must not be less than 2 per cent. of the total capacity of the tank, including the dome and shell capacity combined. If the dome of the tank car does not provide this 2 per cent. sufficient vacant space must be left in the shell of tank to make up the difference.

If we consider 60-degree sulphuric acid as a base for calculation, the coefficient of expansion from 60° F. to 110° F. is 1.56 per cent. This, therefore, makes an actual increase in volume of 100,000 pounds of acid loaded in a tank car, equivalent to 1,560 pounds. Inasmuch as the ordinary dome has a capacity of approximately 700 pounds of acid, the possible overflow is apparent where proper provision has not been made for this expansion. It will be noted that the coefficient provided by the Bureau's specification provides a margin of safety of approximately 30 per cent.

The safety of the tank itself is not considered, as the added pressure is taken care of by the frangible lead disc in the air pipe provided by A. R. A. regulations.

In discharging tank cars, great care should be exercised in making air and acid discharge connections. Many accidents have been caused through the spraying of acid from imperfect connections.

When the unloading of the tank is completed, the operator must see to it that the pressure on the tank is entirely relieved, by uncoupling the air cock first and opening the acid discharge connection last. If this operation is reversed, there is danger of the operator being burned.

Attention is called to another danger which is frequently encountered. Sales orders calling for definite tonnages sometimes result in the shipment of tank cars only partially filled. Furthermore, tank cars are sometimes supplied for loading when there may be insufficient stock to fill the tank. The result is an undue strain on the tank and tank car equipment due to swishing back and forth of the load, thus jeopardizing the safety of the heads and having a tendency to break the tank loose from its anchorage and possibly shift it on the car body.

Tank Car Loading Racks

The rounding surface of a tank car makes a very insecure footing for workmen engaged in removing and replacing dome covers, connecting and disconnecting air lines, etc. Various acids and oils make a slippery footing when spillage is present; weather conditions—frost, snow, etc.—add to the difficulty. Various schemes have been devised to protect the operators in the course of this work, detailed explanations of which have been given in various journals. Properly constructed loading racks should prevent entirely the overfilling of tank cars, a point not to be overlooked or underestimated.

Acid Lines

It may be supposed that overhead lines supported on plank runways constitute a source of danger from possible leakage. This is not actually the case, for overhead lines on account of their exposed position, can be periodically inspected and incipient weaknesses corrected; whereas, in a buried line, a leak is not apparent until the loss is sufficient either to saturate the ground or vent itself from the conduit in which it may be enclosed. Outside corrosion shortens the life of a buried line, while an overhead line can be kept painted and corrosion from the outside reduced to a minimum. Open-flame lights should never be used while repairs are being made to acid lines, pumps, etc., on account of the possible presence of explosive gas.

Gas in Tank

Hydrogen gas is often generated by the action of the sulphuric acid on the metal body of the tank. This gas is highly explosive when ignited and for this reason no light except a storage battery hand lamp or electric torch should be used around acid tanks.

After a tank has been emptied, no one should be allowed to go into tank until it has been completely filled with water and then emptied. Repeated fillings may be necessary, or until the sediment of the tank is well dissipated, otherwise the gas liberated during removal of sediment may result in injury to workman.

*Presented at Boston meeting, National Safety Council, Chemical Section, September 27-28, 1921.

*In particular, National Safety News, October 11, 1920.

Bridge to Tank Dome

Numerous accidents have been caused by slipping and falling from the top of tank cars, particularly in wet and freezing weather, and to avoid this it is recommended that a pivoted swinging bridge be installed; a semaphore or some other signal should be provided to give warning that the car should not be moved while men are working on it.

To Unload Acid from Tank Cars

1. Clean out sediment at bottom of acid discharge pipe by pushing down a $\frac{1}{2}$ -inch pipe with disc on bottom about $\frac{1}{4}$ -inch smaller in diameter than the discharge pipe.
2. Connect up acid discharge pipe and see that gasket is tight.
3. Connect up air pipe and see that gasket is tight.
4. Tighten up manhole plate, turn on air gently and see that manhole gasket is tight, also gasket of discharge pipe.
5. Gradually increase air pressure until acid discharges from tank.
6. Use lowest air pressure consistent with efficient work of unloading.

Air Pipe Equipment

On the platform place a safety valve on air line set to the lowest efficient pressure. This valve to be kept locked and key to be held by the superintendent. Place globe valve on tank side of safety valve, to be closed when tank is emptied and before globe valve on air relief

is opened. This is to protect safety valve from gas from tank.

Acid Platform, Bridge, and Semaphore

A red semaphore should be placed over the acid unloading platform (connection directly to the bridge) so that it will be visible along the railroad track in both directions, whenever a tank is being discharged or any one is working on or in the tank. The semaphore will be over the track when bridge is down, and vertical when bridge is up. Hook on bridge when not in use.

Caution Signs

At each acid unloading platform the following list of DON'TS should be tacked up:

DON'T carry an open light around a tank car when filling or emptying same.

DON'T strike a match or smoke around a tank car.

DON'T use any light except an *electric torch* near or in a tank car.

DON'T fail to see that all gaskets are tight when turning on air pressure.

DON'T fail to open air relief valve before disconnecting acid discharge line.

DON'T use excessive air pressure on tank.

DON'T go into an empty tank after unloading until after it has been completely filled with water and then emptied.

DON'T turn any tank car over to railroad company until you have seen that *all* gaskets are tight.

DON'T take any chances—SAFETY FIRST.

Joseph Priestley

BY the courtesy of Albert Rosenthal we are able to present on the front cover of this number of CHEMICAL AGE a one-half reproduction of his lithograph of his copy of Gilbert Stuart's original painting of Joseph Priestley, which he executed under the direction of a special committee which presented it to the American Chemical Society at its September meeting at Columbia University. The portrait was presented by the Society to the National Museum, Washington, D. C., on October 25th, with appropriate ceremonies under the auspices of the Washington Section.

Albert Rosenthal, the artist, writes us that "to my mind the portrait of Priestley was painted about 1795-96. The painting represents surely a man of sixty or more. He arrived in Philadelphia about 1794 with a distinguished reputation and was a 'martyr' to his convictions. Gilbert Stuart was in Philadelphia at this period. Gilbert Stuart is our foremost portrait painter and no modern painter has displaced him from this position in America. He was born in 1755 and died in 1828."

Joseph Priestley was born near Leeds, England, in 1733, and was educated for the ministry, his first charge being as assistant to a Presbyterian preacher at Needham Market, where the liberality of his opinions cut short his progress in this field, and introduced him to a checkered career as a religious and political controversialist. He took up teaching with greater success and turned a studious disposition and facility of expression into many contributions, chiefly of a controversial nature, to the current thought of his time on many subjects.

Priestley's place in the history of science rests on his discoveries in connection with gases. It will interest fermentation chemists, particularly those familiar with the manufacture of malt liquors, who naturally are much encouraged by the recent turn of events, that it was Priestley's residence near a brewery that lead him

to discover "fixed air" (carbon dioxide) present on the surface of the fermenting liquor.

He devised the simple method of collecting gas by causing it to displace water in a closed vessel, as a great improvement over the method of investigators of his time of collecting it in bladders. His invention of soda water not only procured for him the Copley Medal of the Royal Society, but should as well endear his memory to the American public. He isolated nitric and nitrous oxides, ammonia, hydrochloric acid gas, sulphur dioxide and silicon fluoride, and on August 1, 1774, he produced for the first time "dephlogisticated air" (oxygen) by the decomposition, with the sun's rays focused by a lens, of red oxide of mercury.

Chlorine, now an important commodity in liquid form and long available only in the form of bleaching powder, Priestley isolated in the course of his experiments without realizing its importance and of course without any thought that this gas as an instrument of warfare would influence profoundly the destinies of nations.

Priestley's career was marked by religious controversies which came to a head in 1791, when, residing in Birmingham, he was the victim of mob violence which burned his home and drove him finally to America where he arrived June 4, 1794, settling in Northumberland, Pa., where he lived until his death February 6, 1804.

A profound thinker with the courage of his convictions and fearlessness in their expression, a stormy petrel in the heated religious and political controversies of his time, a prolific writer whose scientific activities were his diversions, he constitutes a unique figure in the history of science and the annals of Pennsylvania and a favorite subject of American chemical antiquarians. The American Chemical Society dates its birth from a pilgrimage to his tomb at Northumberland in 1876.

An Improvement in Evaporator Design

By Robert V. Cook

Chemical Engineer, Chemical Equipment Co.

DESIGN and structure of a chemical machine, however appealing these attributes may be, are of little moment if the efficiency of operation be low; accordingly efficiency of operation is a primary consideration in any departure from accepted types of equipment or procedures of operation in chemical manufacture.

In a series of tests conducted by Prof. H. McCormick, director, department of chemical engineering, Armour Institute of Technology, Chicago, of the new-type evaporator described on page 409, October, 1921, *CHEMICAL AGE*, results were obtained which are summarized in the accompanying table. The evaporator was connected properly to a 2-in. steam-supply line with boiler pressure of 110 pounds gauge. City water, which was the liquid being evaporated, was supplied to the feed trough through a 1-in. pipe. Throughout the tests the liquor chamber was kept about three-fourths full. In this way the top tubes at the ends were kept barely covered. A 4-in. line connected to the top of the evaporator led the vapors to a water-cooled surface condenser; then through a steam-driven piston wet-vacuum pump of suitable size, which discharged into a scale tank. The condensed also was caught in a scale tank, so the quantity of the liquid evaporated and the steam condensed were determined accurately.

TABLE No. 1

Results of tests made under three different sets of steam pressure and vacuum conditions of a criss-cross evaporator having ninety-six (96) $\frac{1}{2}$ in. copper tubes 32 inches long (33.5 square feet heating surface) at Armour Institute of Technology, Chicago, by Prof. H. McCormick, head of Chemical Engineering Department.

	CONDITIONS		
	First Run	Second Run	Third Run
Liquid being evaporated	Water	Water	Water
Vacuum gauge reading	24.5-25 in.	22 in.	21.5 in.
Steam pressure on steam chest	.75-1.0 Lbs.	2.25 Lbs.	5.0 Lbs.
	DATA		
Time taken for run	30 Min.	30 Min.	25 Min.
Weight of condensed vapor	840 Lbs.	1070 Lbs.	900 Lbs.
Weight of steam condensed	897 Lbs.	1142 Lbs.	976 Lbs.
Temperature of condensed steam	194°F.	194°F.	194°F.
Temperature of feed water	84°F.	84°F.	84°F.
	CALCULATIONS		
B.T.U. supplied by steam condensing under conditions described	888,489	1,136,290	979,806
B.T.U. utilized to heat up and evaporate water under these conditions	857,808	1,107,557	936,090
B.T.U. Utilized			
= Efficiency	96.5%	97.4%	95.5%
B.T.U. Supplied			
Water evaporated per minute	28 Lbs.	35.7 Lbs.	36 Lbs.
Water evaporated per lb. steam condensed	.9363 Lbs.	.9369 Lbs.	.922 Lbs.
Evaporative factor = gal. water evaporated per sq. ft. per hour	6.02	7.66	7.73
Total water evaporated per hour	201.67 Gal.	256.8 Gal.	259.2 Gal.

Three runs were made with different steam pressure in the heating tubes and different vacuums above the

liquid. Before each run the machine was operated for some time until conditions such as vacuum, steam pressure, water level, and rate of condensation of steam practically constant. The test then was begun. Table No. 1 gives the vacuum and pressure conditions, the data secured and calculations from the data on the efficiency, the water evaporated per minute, the water evaporated per pound steam condensed, the evaporative factor, and the total evaporative capacity per hour under the different conditions.

The first run, as seen in the table, was made with low steam pressure and with medium vacuum. The second run was with low steam pressure and low vacuum. The third was made with medium steam pressure and low vacuum. These conditions are very unfavorable compared to those generally used in practice, which are from 26-28 in. vacuum and 2-6 lbs. steam pressure. Hence, the factors and ratios given are very conservative indeed, and it is believed that these will be materially increased when we are able to make tests under conditions generally accepted as standard. This was not possible with our set-up because the surface condenser, although it was large, seemed to be unable to handle the large amount of vapors coming over. Also the vapor outlet and the steam inlet proved to be of insufficient size to give more favorable operating conditions. Even with these adverse conditions the evaporative factors and ratios are surprisingly high.

From the table we see that this factor increases as the steam pressure increases. This is due to the fact that the higher pressure steam has the higher velocity, and can, therefore, transmit more heat units and evaporate more gallons per hour per square foot heating surface.

Stating the facts which the table brings out in words, we see that:

- (1) The efficiency (B.T.U. Utilized ÷ B. T. U. Supplied) is exceptionally high, an average figure being 96.46 per cent.
- (2) The evaporative ratio (or the pounds water evaporated per pound steam condensed) is high, an average figure being .9317.
- (3) The evaporative factor is surprisingly high, an average being 7.136 gallons per hr. per sq. ft.
- (4) The total evaporative capacity of this small machine having only 33.5 sq. ft. heating surface is astonishingly high, an average from the tests being 239.22 gallons per hour.

In a comparison of the performance of the criss-cross type of evaporator with that of the standard horizontal-tube type, information as to the performance of horizontal tube evaporators is drawn from a paper published by *CHEMICAL ENGINEER*, July, 1912, under the title, "Heat Transmission in Vacuum Evaporator Tubes," by H. McCormick, H. C. Dormitzer, and E. P. Roleson. This paper gives data on a standard horizontal-tube evaporator, using tubes made of various metals. We select Run No. 1, which was made with copper tubes because the tubes of the criss-cross type are of copper. The horizontal tube evaporator had 12.53 sq. ft. heating surface, or, we might say, was $12.53 \div 33.5$, or .37 as large as the type under discussion.

Notwithstanding this difference in size, it is thought that the efficiency, the evaporative ratio, and the evaporative factor should be comparable. The conditions under which the horizontal tube equipment was operated are far more favorable than those for the criss-cross type, so here again we are very conservative. The con-

ditions of Run 3, Table 1, on the criss-cross type of evaporator more nearly approach the condition of the horizontal tube, so the figures for this run are used in the following table:

TABLE NO. 2

A comparison of efficiency, evaporative capacity, evaporative ratio, and evaporative factor between a criss-cross type and a standard horizontal-tube type evaporator.

CONDITIONS	Criss-Cross Evaporator	Horizontal Tube Evaporator	Com- parison Stated as a Ratio
Liquid being evaporated.	Water	Water	....
Vacuum gauge reading.	21.5 ins.	23.2 ins.	....
Steam pressure on steam chest	5.0 Lbs.	11.8 Lbs.	....
DATA			
Heating surface	33.5 Sq. Ft.	12.53 Sq. Ft.	2.67:1
Time taken for run	25 Min.	120 Min.	....
Weight of condensed vapor	900 Lbs.	243.2 Lbs.	....
Weight of steam condensed	976 Lbs.	306.7 Lbs.	....
Temperature of water.	84°F.	122°F.	....
Temperature of condensed steam	194°F.	167.7°F.	....
CALCULATIONS			
B.T.U. supplied by steam condensing under conditions of test.	979,806	320,655	....
B.T.U. utilized to heat up and evaporate water under these conditions	936,090	245,875	....
B.T.U. Utilized			
= Efficiency	95.5%	75.2%	1.27:1
B.T.U. Supplied			
Water evaporated per minute	36 Lbs.	2.026 Lbs.	17.75:1
Total water evaporated per hour	259.2 Gals.	14.6 Gals.	17.75:1
Evaporative ratio (water evaporated per lb. steam condensed)	.922 Lbs.	.793 Lbs.	1.16:1
Evaporative factor (gal. water evaporated per sq. ft. heating surface per hour)	7.73	1.165	6.63:1
Gal. water evaporated by 33.5 sq. ft. heating surface per hour.	259.2 Gal.	39.03 Gal.	6.63:1

From this comparison we see that the efficiency of the criss-cross type of evaporator is 1.27 times that of the horizontal-tube type; that the evaporative ratio is 1.16 times greater; that the evaporative factor is 6.63 times greater; and that the total evaporative capacity is 17.75 times that of the horizontal-tube type machine, although it has only 2.67 times the heating surface.

The Darco Co., du Pont Building, Wilmington, Del., a subsidiary of the Atlas Powder Co., has acquired about 160 acres at Marshall, Tex., as a site for its new plant for the manufacture of its activated lignite recolonizing agent. The initial works are estimated to cost about \$1,500,000, and to give employment to approximately 500.

* * *

The damage suit of the Union Sulphur Co. against the Texas Gulf Sulphur Co., involving \$6,768,000, has been settled out of court and the case was dismissed by the Federal Court at Houston on Oct. 15. The action filed by the Union Sulphur Co. concerned operations of the Texas Gulf Sulphur Co. in Matagorda, Texas. The plaintiff alleged that the mining operations of the Texas Gulf Sulphur Co. had extended under its line and that sulphur belonging to the plaintiff had been taken.

In its answer the Texas Gulf Sulphur Co. declared it had used the only accepted method of mining for sulphur and it was through no fault of the company, if the land of the Union Sulphur Co. had been damaged.

New Jersey Chemical Society

The regular meeting of the New Jersey Chemical Society on November 14th was notable as the anniversary of the birth of the society on Armistice Day, November 11, 1918, since when it has grown from an eighteen-man organization to one with a present membership of about 800. The attendance despite inclement weather was one of the largest in the history of the society.

Dr. R. B. Moore, physicist and helium expert, U. S. Bureau of Mines, delivered the main talk of the evening, devoted to a discussion of the scientific history and use of helium as an unflammable inflatant of military dirigibles. Following Dr. Moore's interesting narrative of the growth of scientific knowledge of helium from Sir William Ramsay's studies to its present production from natural gas by the government's helium plants at Fort Worth, Texas and Centralia, Kansas, was the appearance of a self-possessed young man whose persistent demands for a hearing of more or less irrelevant comment alienated the sympathy of a large body of the audience. The audience's wishes finally prevailing, he declared that if it would not listen to his remarks he would, with a capable assistant, play the banjo! Whereupon they ascended the rostrum and to the edification and applause of an appreciative audience rendered several selections on the banjo and saxophone. If Wilbert B. Hitchner and Garrett I. Johnson, senior students in chemistry at Rutgers College, New Brunswick, N. J., make as good chemists as they now are musicians, Prof. Ralph G. Wright will have cause to be proud that they are two of his boys.

Preceding Dr. Moore's talk on helium, Prof. Wright, president of the society, announced that the distinction and credit for the conception and establishment of the society resided with Dr. Frederic Dannerth, and called upon him for a few words on the occasion of its birthday.

Dr. Dannerth dwelt upon the remarkable growth of the society as positive proof of the incapacity for the role of prophet of a former president of the American Chemical Society, inasmuch as, without mentioning names, he recalled his assertion that there was no excuse for the existence of the New Jersey Chemical Society and that he would give it two years in which to demonstrate his belief.

Dr. Dannerth's talk was the most important of the evening for it brought to the surface for open discussion the subject of the independent existence of the New Jersey Chemical Society and the gumshoeing of a prominent national executive officer that the American Chemical Society was open for the absorption of an organization that it originally condemned.

Associated with the success of independent chemical organization in New Jersey is the live project of the American Institute of Chemistry which in the United States is essentially a state proposition. As a professional organization of chemically educated men, a growing body of American chemists feel that it should have no organic connection with the American Chemical Society; that it should be a separate and distinct instrument of service growing out of economic organizations of chemists along state lines and adapted to the respective state environments.

Dr. Dannerth performed a distinctive service in drawing out this subject from the seclusion of intrigue and serving notice that the New Jersey Chemical Society resented the meddlesome interference of those who would be gratified with its extinction.

Personal Items

S. L. Willis, formerly ceramics expert, United States Tariff Commission, is now with the Corning Glass Works, Corning, N. Y.

* * *

A. G. Koost, formerly chief chemist for the H. H. Hessler Co., Cleveland, Ohio, is now connected with Liebethal Bros. & Co., of that city.

* * *

G. B. Burnham, formerly manager, Burnham Chemical Co., is now technical director of the company, with offices at 1016 Hobart Building, San Francisco, Cal.

* * *

Dr. John Lee Coulter has been elected president of the North Dakota Agricultural College to succeed Dr. E. F. Ladd, now in the United States Senate.

* * *

E. A. Richardson, formerly with the National Lamp Works, General Electric Co., Cleveland, Ohio, is now chief chemist, Libbey Glass Co., Toledo, Ohio.

* * *

Dr. H. B. Hart, formerly of the department of chemistry, University of Iowa, is now research chemist for the Eagle-Picher Lead Co. at Joplin, Mo.

* * *

M. A. Swayze, formerly of the Texas Portland Cement Co., Houston, Tex., is now chief chemist of the Knickerbocker Portland Cement Co., Hudson, N. Y.

* * *

Dr. Kenneth G. Matheson, president, Georgia College of Technology, has accepted the presidency of Drexel Institute, Phila., Pa., with duties effective April 1, 1922.

* * *

Richard Quinn, formerly plant superintendent, The Muralo Co., New Brighton, N. Y., is now with the United States Kalsomine Co., Newark, N. J., in the same capacity.

* * *

S. G. Byam, formerly chief chemist, Fairfield, Conn., Rubber Works of E. I. duPont de Nemours & Co., is now with the Plymouth Rubber Co., Canton, Mass., in the same capacity.

* * *

Dr. Edgar Smith, president, American Chemical Society, has been appointed adviser on behalf of the chemical industries to the American delegation to the Limitation of Armaments Conference.

* * *

Alfred Chaston Chapman, F.R.S., president of the Institute of Chemistry of Great Britain and Ireland, has been appointed a member of the British Royal Commission on Awards to Inventors.

* * *

E. T. Marceau, chemical director, N. K. Fairbank Co., has transferred his headquarters from Chicago to New York City, in pursuance of the centralization policy of the American Cotton Oil Co.

* * *

William T. Ashley has resigned as vice-president and general manager of the Hauck Nut Butter Co., Newark, N. J., to devote his time to the exploitation of his patents on a new process of margarin manufacture.

* * *

Chas. H. Stone, formerly vice-president and sales manager of the Atlantic Dyestuff Co., Boston, Mass., is now connected with the Textile Alliance, Inc., 45 E. 17th Street, New York, entering upon his new activities November 1st.

A. G. Marshall, 3034 St. Paul street, Baltimore, Md., has resigned as works manager, Davison Chemical Co., and will resume his former profession of consulting chemical engineer specializing in the manufacture of mineral acids and fertilizers.

* * *

James Lynah, long in charge of the duPont fabrikoid plant, Newburgh, N. Y., and O. E. Bernard, well known in the rubber trade, have incorporated as Bernard-Lynah, Inc., 321 Broadway, New York, to act as selling agents for cotton yarns and fabrics for the rubber trade.

* * *

Charles P. Titus, consulting microcopist, East Orange, N. J., and member of board of governors of the New Jersey Chemical Society, lectured on November 4 before the New York Microscopical Society at the Museum of Natural History on "Fabrics Under the Microscope."

* * *

William R. Burton, inventor of the "cracking" process of petroleum distillation used by the Standard Oil Co., and president of the Standard Oil Co. of Indiana, has been awarded the Perkin medal by the Society of Chemical Industry for notable attainments in applied chemistry.

* * *

George H. Jackle, formerly manager, New York office of G. S. Alexander & Co., fertilizer materials, will be associated with his son, Frank P. Jackle, formerly in the purchasing department of the General Chemical Co., as brokers in fertilizer materials, chemicals and oils at 40 Rector street, New York.

* * *

Dr. W. S. Beekman, director of the research laboratory of the Puyallup & Simmon, Fruit Growers Canning Co., Puyallup, Wash., writes that over 10 million pounds of bush fruits per year are handled by his company. To maintain and improve the quality of the canned products and to find outlets for by-products are the chief responsibilities of the laboratory.

* * *

Harrison E. Howe, formerly chairman, Division of Research Extension, National Research Council, has been elected editor of the *Journal of Industrial and Engineering Chemistry* and director of the News Service of the American Chemical Society, to succeed Dr. Charles H. Hertzy, who has accepted the presidency of the Synthetic Organic Chemical Manufacturers' Association.

* * *

A. Campbell, Globe Soap Co., Cincinnati, O., chairman; W. H. Raymond, Armour & Co., Chicago; H. M. Thayer, N. K. Fairbank & Co., Chicago, have been appointed as a committee by the Soap Section of the American Specialty Manufacturers' Association to confer with the Bureau of Standards in a proposed revision of soap specifications contained in the Bureau of Standards circular to be issued in 1916.

* * *

Dr. Walter Nernst, director of the Institute of Physics and Chemistry, University of Berlin, inventor of the Nernst lamp, acquired in the United States by the Westinghouse Electric & Mfg. Co., and soon displaced by the tungsten lamp of the General Electric Co., discoverer of the third law of thermo-dynamics, and head of the scientific staff which produced the German poison gas in the late war, has been awarded the Nobel prize of 1920 for his notable achievements in the domain of electro-chemistry.

Industrial Notes

John R. Anderson & Co., 11 Cliff street, New York, have erected a plant at Union, N. J., for the manufacture of stabilized pitches, electrotype waxes and insulating compounds.

* * *

The United Chemical & Industrial Corp., Widener Building, Philadelphia, Pa., has acquired a substantial interest in the Salts & Chemicals, Ltd., Kitchener, near, Ottawa, Ont.

* * *

The Powdered Coal Engineering & Equipment Co. have moved their offices and manufacturing plant from Chicago to Buffalo, N. Y. J. W. Lansing of Buffalo has been elected president and H. B. Pouden has been appointed chairman of the board.

* * *

Arthur D. Little, Inc., Cambridge, Mass. and Washington, D. C., has established a valuation and appraisal department under the direction of William H. Kobbé formerly valuation engineer connected with the Income Tax Unit, Bureau of Internal Revenue.

* * *

The Laboratory Apparatus Co., Ann Arbor, Mich., has been incorporated with a capital of \$25,000 by Frank Schaefer, Burt F. Schumacher and Fred T. Stowe, Ann Arbor, to manufacture laboratory equipment, precision apparatus, etc.

* * *

Maguire, Patterson & Palmer Co., Pembroke, Ont., Bryant & May, Ltd., London, Eng., and the Diamond Match Co., 111 Broadway, New York, have merged interests in the formation of a Canadian match company which is building a plant at Pembroke, Ont., costing over \$500,000.

* * *

The vast areas of cut-over pine lands of the South are a continual invitation to chemical enterprise to recover the pine chemicals in timber waste and stumps. The Southern Extracts Co., Pensacola, Fla., and the Carolina Pine Products Co., Hamlet, N. C., are recent organizations for this purpose.

* * *

The bond holders of the Union Dye & Chemical Co., Kingsport, Tenn., have acquired at receivers' sale the property of the company and have organized the Kingsport Color Co., which will operate the plant when business conditions become more favorable. The land, buildings and equipment were bought for \$185,000, and \$15,000 was paid for the chemicals on hand.

* * *

The Nashville, Tenn., Chamber of Commerce and the Nashville Industrial Corporation, purchasers of the "Old Hickory" governmental smokeless powder plant, have allied themselves in the creation of an industrial department of the former organization, to facilitate the establishment of new industries either at Nashville or at the site of the former powder plant.

* * *

Lawlor-McCormick Co., New Brunswick, N. J., authorized capital \$50,000, has been incorporated by Clifford J. McCormick, New Brunswick, N. J., Joseph J. Lawlor, New Rochelle, N. Y. and William J. Lawlor, New York City, to take over the exclusive sales agency of the naphthalene products of the Atlantic Chemical Works, Ltd., Bayway, Elizabeth, New Jersey.

* * *

The distribution of twelve and one-half million pounds of salvaged picric acid for land-clearing by the Department of Agriculture, proportioned among the

states according to their areas of cut-over lands, has met with great favor, particularly in Michigan, where requests for 300,000 pounds in excess of the state's allotment have been returned because of the inadequate supply. Michigan's quota was 624,000 pounds.

* * *

The Hardinge Co., 120 Broadway, New York, has acquired the pulverized fuel department of the Quigley Furnace Specialties Co., 26 Cortlandt street, New York, and has added to its staff to handle this new activity H. A. Kimber and L. W. Manso of the latter company, O. M. Rau, formerly consulting engineer Philadelphia Rapid Transit Co., and W. V. Rankin who will act as managing engineer of the new department.

The Quigley company will devote its entire attention to its refractory specialties business.

* * *

The People's Gas Light & Coke Co., Chicago, Ill., through its subsidiary, the Chicago By-Products Coke Co., has completed at a cost of \$18,000,000 what its builders, the Koppers Co., claim is the most modern gas plant in the world. The plant, put in operation Oct. 20, has a daily production capacity of forty million cubic feet of gas, in addition to the associated products, coke, tar and ammonium sulphate, and will consume annually 750,000 tons of coal and twenty million gallons of gas oil in production of both coal and water gas. The plant property covers 600 acres adjoining the drainage canal.

* * *

In pursuance of a policy of rigid economy and manufacturing centralization following upon an operating loss of over two million dollars in the last fiscal year, the American Cotton Oil Co. has abandoned its Chicago plant, the N. K. Fairbank Co., and transferred production to its more modern plants at St. Louis, New Orleans and Guttenberg, N. J. A central sales division will be continued in Chicago. The former Chicago plant, covering four city blocks and embracing 600,000 square feet of floor space and six and one-half million gallons of tank storage, will be sold. The W. K. Fairbank Co. was established in 1865 and became a subsidiary of the American Cotton Oil Co. in 1875.

* * *

The arrangement made between Standard Oil Co. of Indiana and the Texas Co. whereby each can use and license the special patents for the manufacture of gasoline owned by the other, with divisions of royalties, is of significance because both own successful processes now in use. The Standard Oil of Indiana owns the Burton process, which it has licensed to other Standard Oil and certain independent companies, while the Texas Co. owns several processes, the principal ones being the Holmes-Manley and Adams.

The Texas Co. has been using its processes for about 18 months, and has the largest installation outside of the Standard Oil Co.'s at its Port Arthur, Texas refinery. This installation produces 100,000 barrels of gasoline a month. The Texas Co. has not licensed its processes to other companies, as it had been awaiting the outcome of the negotiations which resulted in the present arrangement with the Standard Oil of Indiana.

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A Retrospect and Forecast of Business Conditions

Production Men Must Think More of Reduced Costs Than of Increased Production.

By R. H. Dunham

President, Hercules Powder Co.

WE enter the New Year still uncertain about the course of business in the immediate future, but justifiably with a much more optimistic spirit than a year ago. When we first felt the pinch of hard times late in 1920, we knew there was a period of severe readjustment ahead of us, but we had no way of knowing how much time would elapse before normal conditions would be restored.

We have done much, probably the severest part, of the necessary readjusting during the past year.

Burden of Government Bust Be Lightened.

The nation, as well as individuals and industries which constitute it, must reduce expenses in every way possible to lighten the tremendous tax burden and to encourage business activity. The Washington conference for the limitation of armament, to whatever extent it may be successful, means not only a reduction of national expenditures and less taxes, but it means also the diversion of valuable materials and labor from destructive to constructive use.

The Hercules Powder Company, and each one of its employees, should heartily endorse every movement to reduce expenditures for war purposes as low as our statesmen consider consistent with proper national defense. The interests of our company and all business are far better served by the peaceful prosperity of the nation and the world than by occasional war inflation.

Economic Equilibrium Must Be Restored

True prosperity, as I see it, requires a fair relation between the various factors of industry, so that there may be the fullest employment for all and the freest exchange of commodities among all. No one can say



R. H. DUNHAM

President, Hercules Powder Co.

just what particular thing started the depression that is still with us, but we all know that values were badly inflated when it started.

There are now inequalities in prices which are unjust to certain classes. We cannot have true prosperity until the farmer, for instance, can obtain as much of the products of other industries in exchange for his own, as he has in the past, and the remaining inequalities must be adjusted before we can expect the return of normal conditions and true prosperity.

Analogies of History.

Reference to prices always remind me of the lesson economists draw from the history of prices in this country. They show us that from the high point reached during the War of 1812 prices declined for about twenty-five years and then turned upwards over a period of the same length.

The next peak, reached during the Civil War, was followed by a continuous drop until about 1895 when the trend changed once more and prices advanced steadily until they attained the high levels of 1920.

Since then, as we all know, prices have been declining. I do not feel competent to judge just how exactly past history may forecast the future trend of prices, but we seem surely to be facing a falling of prices whether or not this may continue for twenty-five or thirty years.

Those who believe that history is an accurate guide warn us that the business experience of all who are now managing business was gained when demand exceeded production, that is, in a time of rising prices, and that we much change our mental attitude and our methods, to succeed under conditions exactly opposite to those under which we have prospered in the past.

Production Costs Must Be Reduced

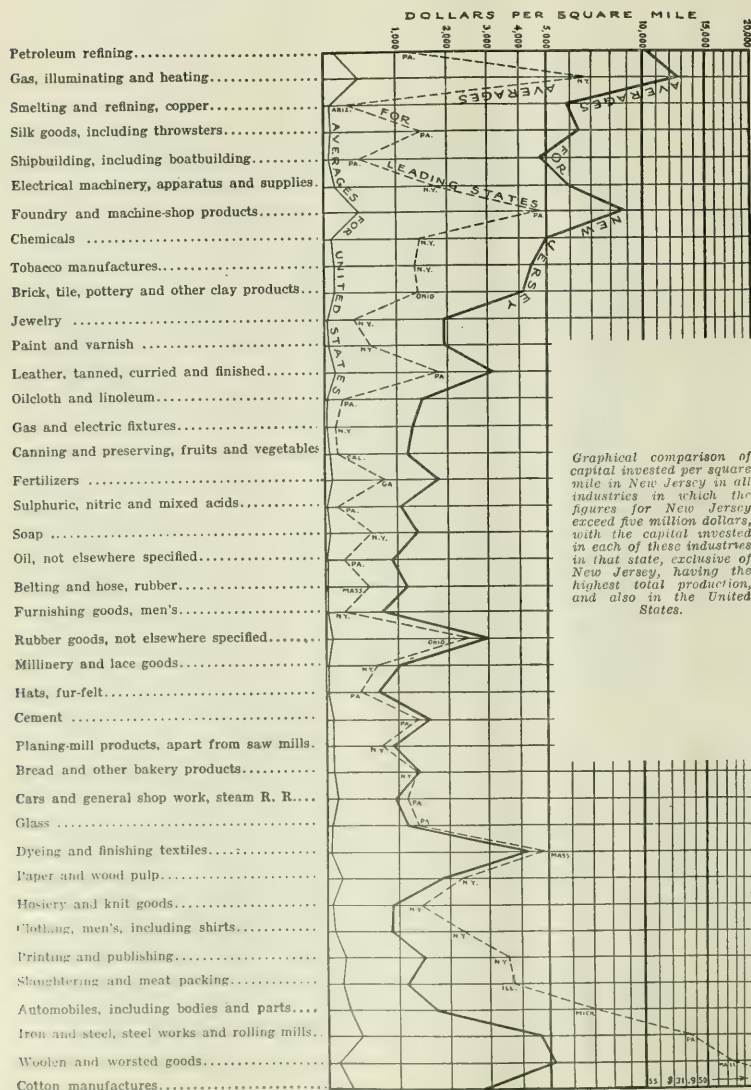
I believe this is sound advice. No matter whether the decline continues for three years or thirty years, we may be sure of several years during which success will depend upon our ability to economize rather than to expand—to play safe rather than to take chances. Production men must think more of reduced costs than of increased production.

Salesmen must expect harder competition; they must work harder to get business, and they must remember that expenses which could be easily absorbed on a rising market may make the difference between profit and loss

when set against a fluctuating or falling market, and perhaps a smaller volume. We must all get a new point of view.

I believe we shall be able to adapt ourselves to the new conditions and that our success will depend upon the speed and completeness with which we do it. I can see nothing, except the possibility that we might fail in this readjustment of mental attitude, to prevent our gaining ground as rapidly as conditions will permit. Success is, of course, a comparative term. Prospects, gauged by the immediate past, do not look bright, but prospects for our own company, gauged by those for business in general, give us much cause for satisfaction.

Chemical Preeminence of New Jersey



PROXIMITY to raw materials, fuel and markets and accessibility unsurpassed because of rail and water transport facilities contribute to make New Jersey the foremost chemical manufacturing state.

The state subdivides readily into three industrial regions—a northern, central and southern. The northern, falling within the metropolitan area of New York, has Newark as its chief city. The central area roughly is tributary to Trenton; the southern to Camden and Philadelphia. Lying as it does, in the path between New York and Philadelphia, and with the advantages stated, the industrial development of the state is logical.

Nevertheless there yet is room for growth, the attractions for which Alfred Gaskill, director of the State Department of Conservation and Development, Trenton, N. J., has printed in an informative booklet, entitled "Industrial Opportunities in New Jersey," from which we take the accompanying graph which visualizes the state's prominence in chemically-controlled manufacture.

This concentration of chemical enterprise, however advantageous from an economic standpoint, has been a deterrent to widespread appreciation of the national importance of chemical industry.

Sources, Preparation and Properties of Algal Gelatins

By Irving A. Field

Late Professor of Biology, Clark College, and Special Investigator, U. S. Bureau of Fisheries.

MANY seaweeds when boiled in water yield a highly gelatinous product called gelose, which is employed in various ways in science, medicine, and commerce. The jellies of the different species of algae vary somewhat in chemical composition and have quite different physical properties. In general, however, gelose will absorb water and swell up, but not dissolve unless heated almost to boiling. The solution coagulates on cooling to a more or less colorless translucent jelly. The gelatinizing power in some cases is more than 10 times that of ordinary animal gelatin. Algal gelatines lose their property of gelatinizing when heated with water under a pressure of six atmospheres or when boiled with dilute acids or alkalis. In a hot solution of dilute hydrochloric acid they yield galactose. Treated with nitric acid they yield mucic and oxalic acids. Some of the American seaweeds that yield gelose are discussed below.*

Irish Moss

Carrageenin is the name given to the gelatinous extract of Irish moss (*Chondrus Crispus*) which grows in abundance on the rock portions of the North Atlantic coast just below low-tide mark. The chief source of supply is centered around Scituate, Mass., where about 30 or more men are engaged in moss collecting. Other localities where the moss is harvested are Cape Porpoise, Portsmouth, York, and Rye, N. H.; Cape Sable, Rockport, Gloucester, Marblehead, Nahant, Cohasset, Plymouth, White Horse Beach, and Cuttyhunk Island, Mass.; Block Island and Montauk, N. Y.

The moss is scraped from the rocks by means of a special rake and spread on a clean sandy beach where it is washed in sea water and sundried alternately several times until bleached white. Dew or light rain assists in the bleaching process, but a heavy rain will ruin the product by extracting the jelly and giving the moss a yellowish discoloration. When ready for market it is packed in barrels or bales weighing about 100 pounds each. In this condition it sold for about 10 cents a pound in 1920.

Chemical analyses show that fresh Irish moss contains 70-80 per cent. water. The water-free substance is composed of:

	Per cent.
Gelatinous matter.....	65
Nitrogen	2-3
Lipoids	0.7-1
Ash	10-15

The ash contains calcium oxalate, sodium, potassium, and magnesium with chlorine, bromine, iodine, and sulphur.

These salts apparently bear an important relation to the properties of the gelatinous matter: for if this matter is extracted after the moss has been washed in fresh water, dilute acid, or alkaline solutions, which would remove the salts, it comes out as a thick mucilaginous mass which fails to jelly on cooling. On the other hand, from quickly dried unbleached moss which has been rinsed for a short time only in sea water and boiled for three to five hours in fresh water in the proportion of 1 part by weight of the dry moss to 50 of water, a stiff gel may be extracted.

Separation of the solution from the insoluble matter is accomplished by filtering the mass roughly through a 1/4-inch mesh galvanized screen and then through one or more layers of cotton flannel. The clear filtrate may be evaporated to dryness on a water bath or in a vacuum chamber, ground into fine flakes, and preserved in airtight receptacles for future use. This method of preparation does not seem to be employed commercially, although it puts the carrageenin in a clean and most convenient form for quick and ready use.

Uses

The gelatinizing properties of Irish moss are easily destroyed by the addition of small quantities of acid, salts and alkalis. Acids in stronger concentrations than 1 per cent. N.S. will liquefy the jelly; neutral salts, and especially calcium salts, increase the firmness of the gel. Perhaps this is why such small quantities of carrageenin are capable of coagulating milk.

Irish moss is used in a variety of ways. It is employed as one of the ingredients of so-called water paints. Certain shoe stains contain a solution of carrageenin for the gloss it imparts when dry. As a sizing for paper, cloth, and thread it is considered excellent. Recently a British patent was taken out for Irish moss extract treated with formaldehyde, which makes a size that becomes insoluble after drying. To a limited extent it is used as a thickening for colors in calico printing and for stiffening silk. Soap manufacturers and barbers use it because of the velvety lather it makes with soap. As a clarifying agent, it has been used extensively in the manufacture of oil and beer. Bandoline is a perfumed muscilage of Irish moss that is employed as an ointment for the hair or fixative for the mustache. As a therapeutic, a decoction of Irish moss with lemon juice serves as a demulcent and emollient in pulmonary affections. It is also recommended for scrofulous complaints, dysentery, diarrhea, and disorders of the kidney and bladder. According to the United States Dispensatory:

Carrageenin is said to have been used as a substitute for acacia under the name of imitation gum arabic; the latter occurs in three forms—white, light yellow, and yellow. They all have similar properties, swelling up like tragacanth when mixed with cold water but not forming a clear solution unless the mixture be boiled, in this latter respect differing from tragacanth or albumen.

Carrageenin extracted from unbleached Irish moss has proved suitable for use as a medium in packing fish that otherwise are too soft to stand up in cans. Experiments show that 1 1/2 to 1 3/4 grams of the dried extract added to a 14-ounce can of fish are sufficient to form a jelly firm enough to prevent such soft fish as whiting and herring from breaking in pieces when subjected to the ordinary rough treatment of transportation.

For many years Irish moss has been used as a food, although its nutritive value is very small. Its importance in this respect lies in the fact that it can render certain very nourishing foods, such as milk, more palatable and increase the variety of ways in which they can be served.

Agar-Agar

Agar-agar is the commercial name applied to the

*Economic Circular No. 51, U. S. Bureau of Fisheries.

dried, gelatinous extract of certain species of red algæ. The algæ most commonly used are *Gelidium corneum*, *G. cartilagineum*, *Gracilaria confervoides*, *Eucheuma spinosum*, and some species belonging to the genera *Gloiopeltis* and *Gigartina*. Of these, the *Gelidium* varieties produce the best quality of agar. Most of the agar of commerce is produced at present in Japan, China, Malaysia, and Ceylon, although there seems to be no reason why the United States should not manufacture more than enough for its needs. During the year 1920 this country imported 240 tons, having a value of nearly half a million dollars.

Preparation

The preparation of agar involves quite a number of steps, but on the whole is a simple process:

(1) The seaweeds are collected by hand or rakes and spread upon the beach to dry and bleach in the sun.

(2) The dry weed is beaten or pounded by hand or passed through a concrete mortar-and-pestle battery to free it from clinging shells, incrusting Bryozoa, sand, and other foreign matter, and is then alternately washed and sundried again until thoroughly bleached and cleaned. This treatment requires from two to several days. Some manufacturers are said to shorten the process by bleaching with chemicals instead of sunlight.

(3) The bleached raw material is boiled with about 50 times its weight of water in an iron kettle for three to five hours to extract the gelose in soluble form. The solution is then separated from the insoluble matter by filtering the mass first through coarse cloths and then squeezing it through linen bags in a press.

(4) The filtered jelly is next poured into wooden trays over 2 feet long, 1 foot wide, and 3 inches deep to cool. As the filtrate cools it solidifies into a hard jelly which the Japanese call "tokoroten." In this form it is cut by means of sharp knives into blocks 1 foot long and 2 inches square. These blocks are in turn pressed through a coarse wire grating which cuts them into bundles of slender straws.

(5) In this condition the "tokoroten" is subjected to a freezing temperature of -5° to 15°C. , either out of doors or in an artificial freezer, until the sticks are frozen solid. This causes the water to crystallize out and when it is melted the substances soluble in cold water drains off in solution leaving the gelose in pure condition. By repeating the freezing and thawing process and at the same time drying the material in the sun and open air a pure agar which is insoluble in cold water is prepared.

(6) Before the sticks are entirely dry they are sometimes put through a forcing machine which flattens each fine strip into a transparent sheet. They are then dried in the sun and tied in bundles weighing from $\frac{1}{2}$ to 3 pounds each.

Agar-agar is prepared also in the form of sheets 8 to 12 inches long and 1 to $1\frac{1}{2}$ inches wide, and as rectangular blocks about 8 inches long and 1 inch square.

The chemical composition of agar-agar has been most carefully studied by Carl R. Fellers.* Analyses of 15 samples collected from various sources and representing different brands gave the following results:

	Per cent.
Moisture.....	15.75-17.84
Protein (N x 6.25).....	163. 2.94
Nitrogen free extract.....	72.72-78.21
Ether extract.....	17. 45
Crude fiber.....	39. 1.60
Ash.....	3.08. 5.68
Silicon dioxide.....	31. 1.11

* *Ind. & Eng. Chem.*, volume 8, No. 12, pages 1128-1133.

Agar-agar has been put to many uses, the number of which is increasing from year to year. It has long been esteemed in China and Japan as a food. It is employed in the preparation of jellies, thickening of soups, ice cream, fruits, meat, or fish, and in candy making. In this country it is used most extensively in hospitals and in bacteriological laboratories. As a base for culture media it is unexcelled by any other substitute, since it remains solid with a smooth, firm surface at the higher temperatures required for cultivating certain species of bacteria. Other jellies are useless because they melt under the requisite conditions.

Recently it has been found to possess considerable therapeutic value in the cure of chronic constipation. Its action is dependent on the fact that it has the property of absorbing and holding water, becoming at the same time a lubricant and mild mechanical stimulant, affected but little by the digestive enzymes. The action is not violent as with ordinary cathartics, and it leaves no harmful after effects. It has also been found a valuable dressing for certain types of wounds. Emulsions for photographic plates much superior to the ordinary gelatin emulsions are claimed to have been made.

Agar-Agar Resources of the United States

A recent very incomplete survey of American seaweeds that yield gelatin has brought to light another one of our valuable natural resources that has been totally neglected. Up to the present time we have been importing agar-agar, an essential product to our general welfare, from countries thousands of miles distant, when a superior product is to be had, probably for less cost, from algæ growing on our own shores. Even should the cost of production prove to be more than that of the imported product, it is important, as a step toward national security, to develop domestic sources of supply. Of a dozen or more species of algæ on the California coast supposed to yield gelatin, the writer has been able to examine four with results that indicate their suitability for all uses to which Irish moss and agar-agar are adapted.

R. S. Lowe, Nitrate Division, Ordnance Department, U. S. A., has been appointed dean of the department of chemical engineering, University of Cincinnati.

* * *

C. R. Alden, formerly dean of the school of engineering, Institute of Technology, Detroit, Mich., is now dean of the college of engineering, Ohio Northern University, Ada, Ohio.

* * *

The Architectural League of New York, 215 West 57th Street, New York, this last year held a great exhibition for a month in the south wing of the Metropolitan Museum, and there realized that the co-ordination of the arts, trades and sciences which go to make the completed structure would benefit materially by more direct attention.

For that reason an aggressive policy has been adopted of bringing the various chemical concerns to the architects and the architects to the chemical concerns, so that they shall mutually understand what each can produce and the advantages of the designer will get by having this knowledge. The results of this getting-together should prove a great benefit not only to the chemical concerns, etc., and the architects, but to the general public. With this idea in view periodical exhibitions are held in the League's rooms at No. 215 West 57th Street, New York, where chemical materials will be displayed and which are open both to members of the architectural profession and to the public. The dates of these exhibitions will be announced shortly.

The Technical School and Industrial Research

By Alfred D. Flinn

Chairman, Division of Engineering in Cooperation with Engineering Foundation, National Research Council

RESearch is earnest, purposeful, persistent, intelligently directed effort to gain new knowledge of a selected subject. The spirit of research is devotion to truth and insistent longing for better understanding*.

Industrial research is research done for industry. It may be (1) in the fundamental sciences, or (2) in the applications of sciences. It is difficult to set limits for the second class, distinguishing research from experimental development of processes, methods or equipment.

Fundamental Research

In the main, the environment of an industrial establishment is not congenial to fundamental research in the sciences. Furthermore, the connection between fundamental research and the business of a given establishment commonly is so attenuated that it is difficult for boards of directors to see justification for expenditure of stockholders' money for such research. Fundamental research, having less immediate connection with commercial profits, there is much less incentive for its control or for secrecy with respect to its results, in the interest of one establishment or group. Hence, fundamental research is especially suitable for those technical schools which can afford research departments. Then, too, such research lies close to the recorded knowledge and the theory with which the student has been familiarizing himself in his courses of study. It is a rare undergraduate, however, who will be competent for more than an assistant's part in research.

Industrial Research—Practical Experience Essential

Industrial research in technology, or applied science, demands practical experience in the industry as a preparation for successful work. Indeed, it can not be done without knowledge of the particular industry. It often requires equipment or facilities of a kind or magnitude which can not be provided in technical schools. Only for limited problems, or under special arrangements, therefore, will this class of research properly be undertaken within a school. Students and faculty members may, however, participate in such research within an industrial plant under suitable conditions. Such direct connections with industry are stimulating to both teachers and students, and help to create a spirit of mutual appreciation between industries and schools.

The fields of research in which industry is concerned must not be too narrowly conceived by the schools. These fields are not limited to physics and chemistry, but include all the mathematical, physical and biological sciences, economics, and, not least, though

mentioned last, those branches of inquiry which relate to men and women in industry, comprised in the term "personnel."

To advance such studies, there has been established by the joint efforts of National Research Council and Engineering Foundation, the Personnel Research Federation. It has for its purpose the correlation of research activities pertaining to personnel in industry, commerce, education and government wherever

researches are conducted in the spirit and with the methods of science. Its membership includes selected national organizations representing scientists, engineers, educators and the American Federation of Labor. The membership is now being widened to include other organizations of kindred interest. It has been learned that there are approximately 250 organizations in the United States giving some attention to personnel research along various lines.

It is surprising to one who has not had a share in the direction of a great engineering enterprise to learn how broad and various is the knowledge demanded in the creation of a Catskill aqueduct, a Panama Canal, a Pennsylvania Railroad system, a Niagara power development, an East River bridge, a Hudson tunnel, a manufacturing plant of modern magnitude, or a great mine.

Duties of Technical Schools

A primary duty of technical schools is to discover young men with genuine research spirit and capacity. For this purpose, psychologists may be able to devise

tests equivalent to those developed by Professor Seashore for detecting innate musical talent. A second obligation is to train these naturally endowed men thoroughly for research careers. The technical schools should distinguish the individual who by nature is a lone worker from the team worker, and train each suitably, but should indicate to all the value of co-operation.

A third obligation is to instill the research spirit into all technical students. The technical school should foster the habit of inquiry—not mere inquisitiveness, but the purposeful search for truth, the alertness that asks "Why" of every phenomenon, the keenness of observation that does not pass indications which the dull-minded would call trivial.

The technical schools should not only discover and educate the rare man with research capacity, but should also train men who can be foremen and technical directors of industrial plants, capable of appreciating research and of working sympathetically with research specialists.

There are numerous ways in which each technical school can give research service to the industries within



ALFRED D. FLINN

Chairman, Division of Engineering in Cooperation with Engineering Foundation, National Research Council

*A paper presented to the Conference on Engineering and Industry in connection with the inauguration of President John Martin Thomas, Pennsylvania State College, October 13, 1921.

the region contributory to the school. Each school may well specialize to some degree according to the needs of its community. Through some central organization, the schools of the country should, however, keep one another informed of contemplated projects and specialties chosen so as to get the most beneficial distribution of such specialization without undesirable duplication. Choice of specialties should vary from time to time with progress in scientific research and change in the needs of industry.

In helpful relationship to research in the industries, the technical schools should teach their students:

1. How to assemble, arrange and analyze conditions so as to state a problem;
2. That it is wise before plunging into a program of work to learn what the literature contains (a large proportion of supposedly original problems can be answered from records of work done, to be found in our libraries);
3. The economy of spending sufficient time to understand the problem and to compare several methods before launching upon any one method of attack;
4. How to select and use the simplest apparatus and method for a given research which will accomplish the purpose, but to make sure of their adequacy; also how to analyze the apparatus and instruments, as well as the method, to detect unsuspected sources of error;
5. To limit the undertaking according to the resources and time available;
6. That there are elements of research in every technical task, which require the ever watchfulness for new light, new aspects, new applications;
7. How to extract research information out of both the ordinary experiences and the unusual happenings in the plant;
8. How to secure the intelligent and enthusiastic co-operation of foremen and operatives in observing closely and reporting accurately in the course of their daily work incidents which may be helpful to a research in progress;
9. The value of research, even when its results seem remote from the present purpose of industry;

10. How to express scientific knowledge interestingly—fascinatingly, but still correctly—in language readily understandable, by directors, managers and other executives;

11. To cultivate some of the journalist's sense of the story in research work;

12. And throughout their courses, the technical schools should teach the fundamentals of the sciences so thoroughly that the graduate can think for himself and will not be at his wits' ends when a problem in his future work does not fall within the limits of the formulae specifically taught or the books available.

Limitations and Potentialities of Research

Research has no end. It must be kept up perpetually. The technical schools must be soundly convinced of this fact and through their graduates, must impart it to the industries, lest unprogressiveness rob the community of the benefit of new knowledge.

Technical schools should convey, also, to their research students some conception of the exigencies and financial necessities of business and instill into them appreciation of the importance and difficulty of the financial problems and patience for the apparent slowness with which industry and business sometimes put into effect the result of research. The scientific man seeks the confidence and appreciation of the business man, and he should reciprocate.

The greatest service of all which the technical schools and the universities can do for industry and for the community is to infuse into all workers from unskilled labor to highest executives that appreciation for truth and that conviction of the futility of deceit which are forced upon the scientist and the technologist, by the very nature of their work. Neither science, nor technology, nor industry, nor business, can permanently flourish on deception or on a narrow and selfish conception of profit.

Public Welfare Demands Minimum of Restriction on the Production and Use of Industrial Alcohol

By James M. Doran

Chief, Industrial Alcohol and Chemical Division,
United States Internal Revenue Bureau

LAW enforcement, speaking in terms of the National Prohibition Act, and the conservation and development of our essential chemical industries depend primarily on our control of the production, distribution and use of alcohol. Beverages containing alcohol have been known and dealt with for centuries. Alcoholic liquors as such, for medicinal uses, similarly have been the subject of age-old controversy. Crystallized public opinion in this country has disposed of these two questions and removed them from controversy, by prohibition in the first case and by regulation in the second.*

It is noteworthy that, coincident with the development of public opinion in our country culminating in the Eighteenth Amendment that outlaws alcoholic liquors for beverage purposes, there was developing our modern organic chemical industry. This industry is taking this same chemical compound, alcohol, that has caused such havoc in times past, and is slowly but surely eliminating the Mr. Hyde side of its properties and characteristics and is turning it into channels that make for real human benefit in every sense of the word. Let the people who have worked earnestly to destroy the evil of the use of alcohol in various forms as a beverage join hands with science not only to solve for all times this

commercial alcohol question insofar as it relates to law enforcement, but in doing so to confer even greater benefits on mankind by further developing its useful side. This I hold to be real constructive work.

Chloroform was first synthesized from alcohol and all anesthetic ether is prepared from alcohol by dehydration. The use of these two chemicals, chloroform and ether, on account of their property to produce anaesthesia has marked an epoch in the development of modern surgery that may be likened to the effect of the discovery of oxygen on the science of chemistry. There is hardly a home in the land that does not at some time or another see one of its members taken through the valley of the shadow under the merciful oblivion of the anesthetic which permits the skilled surgeon to work surely and swiftly in his work of restoration.

Leaving the hospital and sick room for the moment, we see industrial alcohol as the necessary article for the manufacture of thousands of useful products with which we come in contact in our everyday life. It also looms up as the probable fuel for internal combustion engines which will replace in part the limited supply of crude petroleum. Our best informed geologists and oil experts estimate the available supply of unmined petroleum to be sufficient for a 12-20-year demand at the present rate of consumption. The alcohol prob-

* Address before annual convention of the Anti-Saloon League, December 8, Washington, D. C.

lem then is not how thoroughly or completely we can revert to semi-civilization, but how thoroughly and completely we can kill alcohol as a beverage and develop alcohol as a useful servant of all.

I appreciate that I am speaking to people of large experience in law enforcement, but I hope I may be able to present an angle that will not only be of interest, but of some positive benefit. The handling of pure alcohol in the various trades today is one of the most serious questions confronting the administration of the National Prohibition Act. It is also one of the serious problems of the industries themselves. Any solution of this problem, even in part, will be of vast benefit to all concerned.

Denaturation

I want to discuss the denaturation or pre-treatment of commercial alcohol at the source, or while it is still under absolute Government control, with such materials that it will be of no interest thereafter to the criminal but still will serve its useful and legitimate purpose in industry. Denaturation of alcohol in Europe preceded denaturation in our country by many years. It first started as a move to encourage industries depending on alcohol by relieving them from the handicap of the payment of the beverage tax. The denaturants added made it difficult to restore the alcohol to a potable condition and thus defeat the tax laws, but they were not of such a character as prevented the alcohol being used industrially.

We started in this country to provide for the denaturation of alcohol for use in the arts and industries in 1906. Progress at first was slow, but nevertheless it was steady. The amount of alcohol that was denatured increased each year replacing a certain amount of pure alcohol in commerce. It did not replace an equal quantity of alcohol for the reason that new industries were being developed under the stimulus of the tax-free alcohol. There has been a steady increase in the denaturation of alcohol to the present day. The war period was marked by a phenomenal production and denaturation of alcohol for powder, poisonous gases, certain medical supplies and other munitions.

The National Prohibition Act changed the outlook very materially. It became apparent that one of the best law enforcement weapons was the provision of the National Prohibition Act providing for more extended denaturation than had theretofore seemed advisable under existing laws.

While European countries antedated us in the denaturation idea, I believe that we are safe in saying that we are far in advance of them in its application at present. We have now authorized in the United States six formulas for completely denatured alcohol and 58 formulas for specially denatured alcohol. These cover a great variety of general industries and thousands of specific products, but do not as yet provide for pharmaceuticals or other products that may be used internally.

Procedure of Government Surveillance

For those who are not familiar with the Governmental system of denaturation I will outline briefly the plan. Alcohol is produced in a bonded industrial alcohol plant. Government officers are on continuous duty at these plants while they are in operation and the openings to the stills, pipes, tanks, etc., are secured with Government locks, the keys to which are held by the officers. The alcohol after production is measured or gauged as we term it, and is then removed to the adjoining bonded warehouse or bonded denaturing plant, as the case may be. The bonded warehouse is a storage place where the

alcohol is kept under Government lock and key until the proprietor disposes of it either by paying the tax and removing it upon a permit, by removing it to the bonded denaturing house, or by removing it for export or other lawful purpose. A Government officer is on duty at the denaturing plant at all times when operations are being carried on. Here likewise Government locks are on all pipes and tanks to which access to the alcohol could be had. The denaturing, or mixing the alcohol with the material called for in any specific formula, is done under the officers' supervision. As an added precaution all the materials before being used in the denaturing house must be tested and passed by an authorized denatured-alcohol chemist.

Completely denatured alcohol is sold without permit. It contains as denaturing agents methanol, kerosene, pyridin, benzol, etc., depending upon the particular formula called for. It is for general uses, such as automobile radiators, anti-freeze solutions, paints, varnishes and household fuel. Specially denatured alcohol is permitted to go only to a bonded manufacturer and for specific purposes. Its movement is subject to such record and check as enables the Commissioner to know who gets it, how much he gets and what he does with it.

It is through the operation of our "specially denatured alcohol" system that we are able to provide specific formulas for specific manufacturing purposes. Every time we are able to provide a formula for a manufacturer that is adaptable to his produce we eliminate the handling of just so much alcohol. A specially denatured alcohol is of no use to bootleggers and a manufacturer is at once relieved of the anxiety incident to handling and storage of pure alcohol.

During the past six months the Commissioner of Internal Revenue has authorized formulas that have transferred hundreds of legitimate manufacturers from the class using pure alcohol to the class using denatured alcohol. The department works with the manufacturer and it is most gratifying to note the hearty cooperation that has been extended to the Department in the working out of mutual problems. We are at present denaturing, roughly, two-thirds of the alcohol produced and the ratio of denatured to pure alcohol is constantly increasing.

Progress is not spectacular but is methodical and ground once gained is not again lost. There will be a minimum quantity of alcohol in the pure state always required and it is not the purpose of the Department to jeopardize the legitimate business of any manufacturer by forcing the use of denatured alcohol before it is deemed that such use is satisfactory. This is particularly true of large manufacturing houses where a great variety of products are put up and where the use of the denatured alcohol here and there would lead to confusion.

It must be evident, however, that after the number of permittees using pure alcohol diminishes, supervision will become a much easier task than at present. Our formulas no doubt have weak spots, but the chemist is the original optimist and when a formula or product does not suit him he starts in to improve it. We know that much remains to be done and for that reason are anxious to receive help and assistance from all.

Scientific cooperative work is what I am particularly interested in promoting and the members of the Anti-Saloon League can help a great deal by giving their moral support to the constructive scientific side of this work. By the time some of the chemists have been working on this particular problem as long as many of you have in your fight for prohibition I will guarantee that good and lasting results will be apparent to all.

American Institute of Chemical Engineers

THE fourteenth annual meeting of the American Institute of Chemical Engineers at Baltimore, Md., on December 6-9, was marked by a large attendance, over 200 members from all parts of the country being present, and an alert adaptation of its deliberations to the thought of the day as it affects chemical engineering.

Warfare by chemicals was approved and the abolition of the Chemical Warfare Service was condemned in the presidential address of Dr. David Weston, and in addresses by Dr. Raymond J. Bacon, Brigadier General Amos A. Fries, chief of that service, and Benjamin T. Brooks, Mathieson Alkali Works, Inc. Dr. Milton C. Whitaker, vice president U. S. Industrial Alcohol Co., criticized the interference with legitimate industry involved in the Government's practice in the enforcement of prohibition laws. His remarks on this subject appear elsewhere in this issue of CHEMICAL AGE. The discussion by Alfred H. White, professor of chemical engineering, University of Michigan, on "Explosives and Fertilizers," had intimate application to the utilization of Muscle Shoals plant No. 2, and to the blow dealt to American potash production by the recent Deutsches Kalisyndikat and French contracts with domestic fertilizer corporations. What Germany has done to one chemical industry it can do to many unless adequate legislation be forthcoming. L. W. Wallace, executive secretary, Federated Engineering Societies, in dwelling upon the work of his organization, emphasized the imperative necessity of improvement in Patent Office conditions if this arm of government is not to become increasingly derelict in its service to American industry.

Prof. J. C. W. Frazer, at the Johns Hopkins University session, told of the development of a gas mask more efficient than any yet produced and capable of protection against carbon monoxide by its oxidation to dioxide at room temperature by a catalyst. Prof. R. W. Wood, also of Johns Hopkins, discussed the war-time uses of the invisible light rays. At the last session on Friday evening, December 9, Major Edward Holmes, National Lime Association, discussed "Some Aspects of the Lime Industry"; Prof. Cavalier spoke of the work of French chemists in the war. Papers also were presented by A. E. Marshall on "Glass as a Material for Chemical Use," and by W. L. Badger, of the University of Michigan, on "Regenerative Evaporation."

The prominence of chemical industry in the Baltimore district and proximity to Edgewood Arsenal provided ample opportunities for industrial trips which were made to the plants of the American Refractories Co., Davison Chemical Co. and Silica Gel Corp., J. S. Industrial Alcohol Co., McCormick & Co., Maryland Biscuit Co., Chocolate Products Co., Hendler Ice Cream Co., Swindell Glass Co., Edgewood Arsenal, etc. Naval Academy at Annapolis was visited on Thursday p. m., December 8.

The local committee, of which A. E. Marshall, consulting chemical engineer, Baltimore, Md., was chairman, merits the commendation of all in attendance for its entertainment of the Institute and in making possible one of the most constructive sessions of this important organization. The following officers were elected:

President, Henry Howard, Grasselli Chemical Co., Cleveland, Ohio; First Vice-President, Dr. A. W. Smith, professor of chemistry, Case School of Applied

Science, Cleveland, Ohio; Second Vice-President, Hugh K. Moore, chief chemist, Brown Co., Berlin, N. H.; Third Vice-President, H. S. Miner, chief chemist, Welsbach Co., Philadelphia; Secretary, Dr. John C. Olsen, professor of chemical engineering, Polytechnic Institute, Brooklyn, N. Y.; Treasurer, F. W. Frerichs, of St. Louis, Mo. Additional members of the Board comprise: W. H. Bassett, American Brass Co., Bridgeport, Conn.; Dr. A. C. Langmuir, Hastings, N. Y.; Dr. Alfred H. White, professor of chemical engineering, University of Michigan.

Deflation in the Tanning Industry

Industries vary in the degree of depression and loss suffered in the readjustment from the temporary and artificial prosperity of the war and post-war periods. In general it may be said that the closer the industry to the products of the soil, the more drastic has been the readjustment to the newer price levels. In the tanning industry, a historic art that has come under chemical control, inflation has been undergone at the cost of staggering losses. Financial problems have been solved. The older companies have overcome these without raising additional capital, but one of the newer concerns, capitalized at about the peak of inflation, has found it necessary to raise new money. With respect to 1922, leather men are cautious about making predictions. Some are mildly optimistic. The year through which they have passed is without parallel in memory of men of fifty years' experience, and this makes them timid about attempting forecasts. The tanning industry entered 1921 in the throes of depression which had set in about the middle of 1920. Packers' hides, which sold at the peak in 1919 at 52 cents a pound, were around 18 cents. The price fell to 9 cents in April, 1921, from which it has recovered to about the level at the start of the year. During the early part of the year many tanneries closed down.

The most disturbing factor is the increase in stocks of sole leather. These are probably 15 per cent. greater than at the start of the year. This condition is not favorable to any advance in leather prices, which are back to pre-war levels. Thus the industry enters 1922 with large supplies of leather, and raw materials advancing and growing scarcer, forecasting curtailment of operations.

There is considerable improvement in the labor situation. Compared with the peak, wages are off about 30 per cent., but still remain 100 per cent. above pre-war level. Increased efficiency has served to liquidate labor further than comparative figures indicate. There appears need for further reductions in wages. With labor still high and hide prices advancing while the leather market is held down by large stocks, the outlook is not promising for the tanner. Low volume of operations is also helping to keep up production costs.

Henry F. Kleinfeldt, secretary, Abbe Engineering Co., New York, has resumed his executive duties with the company and its related interests following an absence, due to illness, of more than six months.

* * *

S. W. Eckman, prominent in the activities of the American Specialty Mfgs. Association and a leader in the development of the section devoted to soap and kindred products, has resigned as president and general manager of B. T. Babbitt, Inc.

Peat as a Carrier for Bacteria

The Functions of Peat in Soil Fertilization and Plant Growth

By Dr. G. H. Earp-Thomas

Director of Research, Earp-Thomas Cultures Corp.

PEAT has been utilized for years as a fuel, fertilizer-filler, stock-food, litter, and as a bacterial food or carrier, mostly the latter. We are interested mainly in peat as regards its place in the growth and development of beneficial bacteria.*

Of the many varieties of peat the black, thoroughly decomposed type is the most desirable kind to use, as such peat is more thoroughly oxidized, heavier, more compact, and contains less of the bacterial inhibitory acids such as geic, apocrenic, and ulmic. The humic acids are less troublesome than the others, as they can be controlled for bacterial purposes by a thorough weathering by exposure to the sun and air, inoculation of beneficial varieties of soil bacteria, and by applications of lime, thus converting the humic acid into humates of lime, etc.

A great deal of study and experimental work has been done to utilize peat in its different forms for the growth of bacteria of various kinds, particularly fertilizing varieties, notably the legume varieties, for the inoculation of seed; but the results have often proved disappointing, as so much depends upon the condition of the peat and the locality from which it has been selected.

I know of a particular case in New Jersey where legume bacteria grew vigorously and produced good clover with an abundance of nodules in a peat bed where the conditions for their growth proved good; while just across the hill, within a mile from this property, on a peat bed very similar in appearance but not so well drained, the same bacteria failed to grow; it acted like a germicide.

So the conditions of the peat bed and the topography of the country have the greatest influence in determining the suitability of peat for bacterization. With undertilling this land has since shown very satisfactory results. The drainage was a very vital factor in bringing out the plant-food values of this peat. Much of this was locked up in the form of complex chemical compounds which are poisonous to plants. They are produced by the growth of Protozoans (small animal forms which are the greatest natural enemies of bacteria and greedily live upon them). But fortunately they are destroyed more or less by drainage; and then the beneficial soil bacteria live upon and break up the gummy complex chemical bodies, converting them into soluble plant foods, which largely accounts for the wonderful results, which are usually produced the third season, from peat beds which are cleared and drained.

It is of course possible with money to make almost any bed of peat a favorable medium for such bacteria. But from my experience, after fifteen years of careful study. I feel that the least amount of money spent on preliminary treatment the better at this time, as peat is dear enough to move even under the most satisfactory conditions. As one of my associates said after the first three months' experience of bringing in peat to the plant: "It looks as if it could be moved in for 30 cents a ton, but when it is in it costs about \$30." But there is a way to move peat economically from almost any given locality, but that is a problem for the engineer,

and interests us only in so far as it relates to its removal as food for bacteria.

I have always said and still believe that the only way to determine the suitability of peat as a bacterial food and carrier is to put the bacteria in the well-prepared, natural bed and find out how long they survive and how many you can take out. This may sound like a big job to the uninitiated but it is very simple to the bacteriologist. If they grow and propagate the material can be called first-class. If they all die, it is necessary for further, careful work to find out the remedy and the cost of correcting the condition. Usually more drainage and lime is necessary, and sterilization of the peat essential. This work is slow and expensive, and it is often better to select a bed of humus in a locality which lends itself to more favorable development.

In selecting a bed it is advisable to examine the surrounding conditions very carefully. Rising, high, dry land with luxuriant vegetation, strong bark and evenly arranged branches on trees, with well-developed leaves and a plentiful supply of blossoms, and where grass and clovers grow abundantly, are an indication of an ideal condition. The peat area should lend itself to easy and complete drainage. The springs should be tapped at their source by main drains and undertilling for lateral or open drains placed suitably apart throughout the cultivated area. The drains should be so arranged that irrigation can be supplied at will. With this condition brought about it is advisable, after the drainage has been in operation long enough to bring about the right texture of the peat bed, to test it in various localities for its reaction, and correct the acidity to a slightly alkaline point by the application of lime and wood ashes.

It should be cultivated carefully and inoculated with nitrogen bacteria and planted to various legumes to determine its conditions. In from fourteen days to six weeks nodules should be visible on the roots of any legumes, and it may then be assumed that the peat is in favorable condition for bacterial action as a fertilizer filler and plant and soil developer. The resultant crops of any kind will have a greater nutrient value for feeding purposes, because the flora is of a favorable kind to produce clean, healthy byproducts to be digested by the plants.

Plants have to some extent a selective ability in regard to soil solutions upon which they subsist, but only to a limited degree. As an example: Asparagus can live in a salt bed and still utilize potash for its growth and development and exclude the soda, taking only sufficient for its requirements; whereas, lettuce would be surfeited with soda and obtain no potash, and the cells would shrink and perish, due to excess of soda. The same condition applies to many other crops and their food materials, and often leads to crop failures. After cultivation has proceeded for a short time it is often noted that an excess of salts or other toxic elements in the soil are washed out by recurrent rains, and if certain crops fail in the first and even the second year of trial, it need not be concluded that they will not do well in subsequent seasons. By heavily inoculating such soils a much more rapid recovery will take place,

*An address before American Peat Society, September 9, 1921, New York City.

especially when legumes are planted. But the inoculation must be repeated each season, as many bacteria are lost in the struggle for supremacy.

It is true that a toxic soil produces toxic food crops which are more or less unpalatable and certainly not conducive to good health—all of which has a distinct bearing on the preparation of fertilizing materials for producing food plants in a healthy and nourishing condition.

The invaluable vitamins of all kinds originate in the soil through bacterial action and are absorbed into the plant and become a valuable and essential part of the tissue-building qualities of such plants. Many bacteria of the soil are vitamin producers and undoubtedly get these strange chemical bodies from the soil they inhabit, but the reactions must be right in the soil for such micro-organisms to grow or the food will lack the vitamins, and possibly the soil likewise. The crop cannot exclude all toxins any more than the lettuce can exclude an excess of soda. Such toxins find their way eventually into the alimentary canal of man and beast, and use up energy to be eliminated or neutralized, or produce a favorable nidus for disease bacteria to enter and attack the individual absorbing such refuse. Finally such matter enters the blood and produces kidney lesions and other disturbances which are directly responsible for shortening the natural span of life.

So it can be seen that good health arises from the soil, as well as all our wealth. Any very remarkable improvement in our health condition must arise from its fundamental source—the soil. By improving the soil conditions so that we can have a well-balanced ration of good material, both animal and vegetable, metabolism will take care of our health as nature intended it should.

We are all chemists enough to determine by one of our special senses, the organ of taste, the quality of the food we eat. The food of any kind from a healthy soil is of luscious flavor, showing that it is of good chemical composition, holding the elements necessary for body-building, and free from toxic matter of an injurious kind. This proves very clearly the necessity for careful soil preparation, so that crops may be produced under the right condition to promote health and maintain mankind in a physically fit condition.

What the gastric juice is to the stomach in the digestion of food, the bacteria of the soil are to the plant. The soil must be digested by weathering and by bacterial action for the crop to survive. I believe future progress in soil development will come from the soil bacteriologist rather than the soil chemist.

For the last two decades many attempts have been made to utilize peat as a bacteria carrier, with more or less success, but nothing yet has been accomplished which can be called at all startling. Most of the work has been limited to the production of inoculated humus for legume culture, but I believe that within the next five years there will be produced inoculated humus compounds that will show far superior results in crop production of a clean, healthy kind than has hitherto been possible with manure or chemical fertilizers. The trouble is that too few biochemists have been working on the problem, and too much pessimism exists among the laity and the professional world as to the necessity and efficiency of bacteria for such purposes. But enough already has been accomplished in the crudest factories, with but superficial guidance, to show that inoculated humus compounds can produce vegetation second to none.

In Virginia in 1918 nine first prizes were awarded to farmers who exhibited produce raised by inoculated humus compounds, and many reports showed that a

large percentage of the users of the material had had results that were superior to anything hitherto tried. But again, the product was not standardized. The humus was not always of the same good quality, which soon became apparent by laboratory examination. Where the count of beneficial bacteria was 30 billions to the gram of material, excellent results were obtained when used at the rate of 500 lbs. to the acre; but in some lots of humus the count was but a few thousand, and the material had to be condemned. Hosts of the natural enemies of bacteria in the form of protozoans had mastered the field. These small animals greedily devour bacteria and leave in the soil highly complex chemicals which are neither food for plants nor animals, but are readily broken down by the action of good soil bacteria into soluble plant foods. The frozen protozoans must be controlled both in the fertilizing material and in the soil. I believe that many diseases of plants are directly traceable to their baneful influence. They can be eliminated by proper preparation of humus, by sterilization, dryness, and by application of chemicals or lime; but it is best to free the humus bed of the pests—start right and prevent a world of trouble afterward through their depredations.

The most valuable bacteria for humus-fertilizing compound include the nitrogen-gathering bacteria, both the *Pseudomonas Radicicola* for legumes and the azotobacter nitrogen-gathering bacteria for general crops, the acid bacteria, nitrifiers, and the sulphur bacteria—all bacteria found in very favorable soils, which under carefully checked-up tests show themselves to be of special benefit in decomposing either the organic or the mineral matter of the soil. Some soils are unfavorable to their development through lack of drainage, poor cultivation or the wrong reaction. The condition should be corrected before the most favorable results can be expected. It is more profitable to have a few acres in prime condition than a large acreage unproductive or unfavorable.

A humus fertilizing compound should be alive with crop-producing bacteria of at least 30 billions to the gram. The reaction should be 1 per cent. alkaline; the material should contain phosphates to meet soil requirements, and potash for all root and other crops requiring this element in large quantity. Enough lime should be supplied to the soil at least to bring it to a neutral reaction. The condition then will be favorable for the humus fertilizing compound, and to show that soil development for a profitable, healthy crop is largely a matter of the proper bacterization of the soil, through the use of peat properly prepared, the most valuable of all bacteria carriers.

Major Gen. Beach, chief of army engineers, reports that seven and one-half million dollars "can be expended profitably" in 1922-23 on the Muscle Shoals nitrate and water power project. He states that the expenditure of \$15,278,828 finds the work about one-third completed. The amount expended in the fiscal year ended June 30, 1921 was \$7,840,781. Work on the project was shut down last April as a result of the refusal of Congress to appropriate further funds for it. Over against the estimates of the War Department engineers is Henry Ford's claim that his engineers can complete the work in one-third less time than the Government estimates and at a cost not exceeding \$18-20,000,000.

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Dr. Lansing S. Wells, formerly research chemist, The Barrett Company, Frankford, Philadelphia, Pa., has been appointed assistant professor of organic and physical chemistry, Montana State College, Bozeman, Mont.

Bentonite

A Natural Product With Industrial Possibilities.

By Raymond B. Ladoo

Mineral Technologist, United States Bureau of Mines

THE name "bentonite" has been applied to a group or series of clay-like materials characterized by an alkaline oxide and alkaline earth content of 5-10 per cent., fine grain size, high absorptive powers, and usually very strong colloidal properties.

Bentonite probably represents no mineral of fixed composition, and its physical properties vary considerably. The type material from Wyoming is light yellow or greenish yellow in color, but from other localities it may be cream colored, white, gray, pink, dark brown, or even black. It is exceedingly fine grained, very plastic and highly absorbent. The appearance may be dull or powdery, but a freshly cut surface usually has a waxy luster. Some varieties have the appearance of wax and may be cut into very thin, translucent shavings. The fracture of the type material is roughly conchoidal, that of other varieties is platy and shale-like, while still others have no typical fracture.

Bentonite is highly absorbent; when wetted it will absorb more than three times its weight or seven times its volume of water. Some varieties when wetted with water expand to more than six times (some experimenters report eight times) their original volume. The wetted material is exceedingly smooth and soft and feels like soft soap. Unlike most clays, bentonite is easily fusible at a comparatively low temperature. Under a high-power microscope bentonite seems to consist of extremely small, more or less rounded, grains of uniform size, but the texture of most varieties is so fine that individual grains can not be distinguished.

Some varieties when finely ground and thoroughly agitated with water will stay in suspension indefinitely, forming a translucent gelatinous mass. The addition of small amounts of acids or sodium chloride seems to have little or no tendency to aid coagulation or settling. Other varieties of similar analysis and appearance go into suspension more easily, but settle out again in a comparatively short time. It has been suggested that the material which stays in suspension indefinitely is a true colloid of the emulsion or lyophilic type.

Chemical Properties

Some, and perhaps all, of the minerals of the bentonite group have the property of allowing easy replacement of the alkaline and earth oxides, one with another. This property has been utilized by at least one company for the softening of certain types of hard water. If hard water containing calcium sulphate be passed through a mass of bentonite containing sodium, the calcium is changed to sodium sulphate (soluble) and the sodium in the bentonite is replaced by calcium. The process is reversible and the bentonite may be rejuvenated by passing through it a solution of sodium chloride. The sodium is restored to the bentonite and the calcium is removed as a chloride. It is probable that carbonates are removable in the same way. This easy replaceability of the alkaline oxides may have an important bearing upon the physical properties of the bentonites. For example, it is possible that the differences in colloidal properties of various bentonites may be due to the variation in the relative percentage of the alkaline oxides.

Occurrence

Wyoming. In Wyoming, bentonite occurs in the lower Benton formation of Cretaceous Age in many parts of the State, but the most important localities have been found to be in the Laramie and Big Horn Basins. It occurs in beds varying in thickness from a few inches to more than five feet, usually both overlain and underlain by a shale of very dark color. The beds usually lie nearly flat and are exposed over wide areas. The commercial deposits are covered by only a few inches of weathered material, so that very little stripping is required. Rough joints perpendicular to the bedding permit the material to be broken down easily. The clay is removed by hand, shoveled into wagons and hauled to the nearest railroad siding, where it is loaded into box cars without further preparation. Some of the Wyoming bentonite is shipped to Chicago for grinding. The principal producers in Wyoming are at Rock River, Newcastle, Cheyenne, and Medicine Bow.

California. In California many deposits of bentonite have been reported, and at least one has been worked. In San Bernardino County, between Barstow and Daggett, a deposit of excellent, white, highly colloidal material has been opened by underground methods. The product is shipped to Los Angeles, where it is ground, sized by air separation and bagged for shipment. Near Otay, San Diego County, are found deposits of an exceedingly fine grained waxy material, white or pink in color, resembling the typical bentonite in composition, grain size, feel, etc., but lacking the property of staying in suspension indefinitely. Experiments have been made with this material as a substitute for fuller's earth in oil refining.

South Dakota. At Ardmore, South Dakota, the Pierre shales contain strata of a gray, fine-grained, clay-like material in nearly horizontal beds six inches to three feet thick. This material was originally known as bentonite, but as it differed somewhat from the Wyoming bentonite the name ardmorite has been applied to it. The principal differences seems to be that it will not stay in suspension indefinitely. The beds are overlain by two to six feet of black soil and usually underlain by thin bedded black shales. In mining, the surface material is stripped off with a steam shovel. The beds of ardmorite are then drilled by hand, blasted with dynamite, and the loosened material shoveled into motor trucks which transport it to the mill at the railroad. This material is used for the manufacture of a water softener, and the milling process is more complicated than is common in most bentonite treatment.

Preparation for Use as a Water-Softener

The following description of the process was furnished by the company. The raw material is first allowed to age and weather in stock piles in the open air. From the stock piles the material is placed in thin layers on steam coils, where it dries and partly disintegrates. From the steam coils it goes to a hammer mill for coarse crushings, thence to screens to remove impurities, thence to disintegrators. From the disintegrators it is conveyed to a pug mill, where it is mixed with water and kneaded.

The plastic clay is then fed to an extrusion press.

where it is forced out through a die in small strings, 1-16 inch to $\frac{1}{8}$ -inch in diameter, resembling noodles. The strings of clay are placed in wire bottom trays, racked on cars and slowly passed through a continuous, steam-heated drying tunnel. The dried strings are sent to a hammer mill and thence to a screen, to remove the fines, which are sent back for reprocessing. The product then passes through a 6x60 ft. oil-fired, rotary kiln, where it is baked at a high temperature.

The baked material is then re-hydrated, with a hydrating solution, in large steel vats heated by steam coils. The rehydrating material is washed with water in cylindrical wooden towers, 3 feet in diameter by 12 feet high, again screened to remove fines, drained and either packed in barrels or put in storage vats.

At Belle Fourche, South Dakota is found a yellow, fine-grained, exceedingly plastic bentonite, closely resembling the Wyoming material, especially when wetted. In suspension in water it forms the peculiar jelly-like mass common to the Wyoming bentonite.

Other States. Deposits of bentonite have been reported at various localities in Montana, Arizona, Utah, Texas and Tennessee. Near Declo, Idaho is found a very dark brown material closely resembling the Wyoming bentonite in every way except in color. The dark brown color is apparently not due to organic material. This clay forms the characteristic gelatinous suspension.

In New Mexico, about 35 miles north of Santa Fe near the Denver and Rio Grande Railroad, are deposits of bentonite three to five feet thick. This material is of pink or flesh color and has a waxy luster. It disintegrates rapidly in water to a soapy, flocculent mass but it does not stay in suspension.

A deposit of bentonite about nine feet thick has been reported at Merritt, British Columbia. It is also stated that other deposits are known in the Nicola and Similkameen mining divisions of British Columbia.

Production and Prices

Considering the unusual physical and chemical properties of bentonite, production has been remarkably small. From 1888 to 1895, the production averaged 60 tons per year valued at about \$25 per ton f. o. b. cars. In 1902, the production rose to 1200 tons but the price dropped to \$5, later rising to \$6 or \$7 per ton.

In 1919, the Wyoming production was at the rate of about 25 cars per year, valued at \$7 per ton. During 1920 and 1921, interest in bentonite greatly increased, new deposits were opened, and it is expected that the production will expand more or less rapidly. It is reported that powdered bentonite from Wyoming and California would sell in eastern markets at \$25 to \$30 per ton in car lots.

Utilization

Until very recently the uses for bentonite were relatively unimportant. These seem to have been practically in the manufacture of the medical dressing, antiphlogistine; in the manufacture of a packing and dressing for horses' hoofs; as a retarder in the manufacture of gypsum wall plaster; as a filler in the manufacture of paper (at a mill in Denver); as a filler in soap; as an adulterant in drugs and candies.

Within the last few years the unusual properties of bentonite have attracted considerable scientific attention, and systematic research has been undertaken to study this material and to develop the best method for its utilization. The Forest Products Laboratory, Madison, Wisconsin, has made rather exhaustive tests on the use in paper of a high-grade variety of light yellow,

colloidal, Wyoming bentonite, known as Wilkinite. Their tests seem to show that the addition of small amounts of bentonite to the clay used as a paper filler greatly increases the percentage of filler retention in the finished product. Thus, in one test the retention with clay alone was 45 per cent; with 20 per cent bentonite and 80 per cent clay, 64 per cent; and with 100 per cent bentonite; 84 per cent. Some paper companies that have tried out this material claim the additional advantages of complete suspension in water and the production of a paper of superior "feel". Other paper companies admit some of the advantages of using bentonite but object to the yellow color of the Wyoming material and submit that the advantages are not sufficient to warrant the increased cost involved. It is reported that the Forest Products Laboratory seems to absorb all the ink with out affecting the pulp.

In the manufacture of soap it has been proved that some bentonites can actually replace 25 to 50 per cent of the soap substance, producing a soap equal or superior to the ordinary soap. It should be noted that bentonite is not used in soap as an adulterant or scouring agent, but actually replaces part of the soap substance and increases the lathering and detergent properties.

Owing to the extremely fine grain size of bentonite the suggestion has been made that it would be suitable as a filler for rubber. It might also be used as a filler for phonograph records, textiles, cordage, pressed and molded electrical insulation, etc. It seems to have interesting possibilities in the manufacture of paint.

As an ingredient in gypsum and lime plasters, bentonite should add plasticity, but it would probably increase the drying shrinkage. Its high plasticity suggests its possible application in ceramics, thus enabling smaller quantities of bonding clay to be used; and the possibility of replacing the bonding clay used in electrical and chemical porcelain, abrasive wheels, and graphite crucibles with bentonite is being considered.

It is reported that some bentonites make a superior adhesive paste, particularly for sticking paper to metal. It is claimed that labels pasted on iron with bentonite will not curl up and drop off. The great affinity of bentonite for water has suggested the possibility of devising a method for using it to dewater crude petroleum.

The use of material of the general nature of bentonite as a water softener has been partly described above. It is not definitely known whether all bentonites possess the property of softening water, but the usual presence of the alkaline oxides suggests this possibility. If this property is common to all varieties it is probable that other uses based thereon may be devised. Other uses suggested for bentonite are: as a base for massage creams; a base for the precipitation of lake colors; a base for printers' ink; as a heavy lubricant or grease (mixed with oil); and as a filler or dressing for leather.

O. H. Wurster and W. E. Sanger, chemical engineers long identified with the fat and oil industries, have engaged in independent chemical engineering practice at 5201 Kinwood Ave., Chicago, Ills., and will specialize in the soaps, fatty acids and glycerin industry.

* * *

R. C. Parker, formerly of the Cornell University Extension Service, has been appointed head of the Eastern Bureau of the National Lime Association with headquarters at Springfield, Mass., where he will co-operate with educational agencies in promotion of the use of lime in New England.

American Institute of Chemistry

MAN ever surpasses in his needs and demands the capacity of agencies created to satisfy them. The most serviceable, and hence the most stable, of human institutions are those that adapt themselves most effectively to the needs and aspirations of those they were created to serve. If institutions do not so adapt themselves to the changing human relationships, their extinction does not necessarily follow, for they may hold true to their original purpose and by so doing increase the efficiency of their special functions.

Power is the common goal, expressed as it may be in whatever form as satisfies the ambition of the individual or institution. Power for education is doubtless the most beneficent that can engage the interest of an institution. In the growth of the service of such an institution, specialization of function is as natural an essential to efficiency as it is in the growth of industry, and so we witness in every line of intellectual endeavor the division of societies to meet the needs of their supporters.

In every group organized for any purpose the responsibilities of management flow first to those most alert to its purpose or best qualified to advance it, and so is built up an interior structure held together by motives of individual interest and which in course of time becomes largely a self-perpetuating machine. Ancillary to the functioning of control is developed a sycophancy which seeks to bask in the sunshine of the machine's regard that recommendations, favors, emoluments and jobs may come to those who grace the court. Democracy grows into aristocracy; the latter into oligarchy and the crowd lives in fear of the favor of the few.

Power is the sweetest dream of man, to conserve which the few always have sacrificed the interests of the many; which procedure in any organization, whatever may be its character, involves the stultification of those who would question the wisdom of the few. This is the experience of human progress in every line of endeavor.

Associations of men for definite purposes, which in their growth have adhered strictly to those purposes, exist cooperatively with later organizations whose objects either are different or which have arisen because of the deficient service of the former. In every case has had to be met in their formative period the hostility of the machine of the older organization.

Coincident with the growth of power of the machine is the magnification of the fetish of organization which condemns not only any disposition within the organization that would disturb the machinery of government, but enterprise in segregation without the organization that it is felt might bear the seed of possible disruption. In this aspect of the growth of associations the machinery of organization is glorified at the sacrifice of the welfare of the membership.

Subserviency to the will of the machine is enforced by the fear of loss of jobs, of difficulty in procuring jobs, or of obtaining recognition of any kind from those in a position to aid in one's material advancement and who control or uphold the machine.

The lash of the displeasure of those whose recom-

mendation or favor is valued is a powerful weapon to suppress independence in thought and action in all associations, and cultivates among the servitors of the machine a hypocrisy repugnant to those with the courage of their convictions and fearless in the expression of the truth.

And so grows up a system with its ramifications in every department of the field of the association's interest, that to antagonize which means to unleash the passions of men fired by the thought that their idol has been desecrated. There is nothing sacrosanct about anything created by man. When there is a belief to the contrary, it is high time for a revision of the faith.

As associations grow in influence, the value of the direction and control of that influence acquires an importance that warrants the activity of special interests in the particular field, that can use it to advantage. Where this advantage, in whatever concrete form it may assume, reacts to the general benefit of the field, no violence to preconceived ideas can be assumed other than what would be expected when practical men get together. It is only when the association is used for class ends does this aspect of group psychology become notable.

Just as all history, particularly recent history, is a narrative of the clash between those who have and those who haven't, so association history records the recognition of those who have and the struggle of those who haven't to break into that class. In other words, the personnel of group domination determines the activity of the association. The fact that an association is directed and controlled by the employing element, by the element that has arrived and left behind sympathetic contact with those in varying stages of the process of arrival, is the cornerstone of the most virile example of association known today.

Thoughtful men understand that organized action is no substitute for individual incapacity, that each man must solve his own problems and bear alone the burden of his inheritance. They realize in this day of the study of the elimination of waste that the educated, professionally trained human element in industry shall receive the consideration of its demands and be denied not by men of their own kind who may have won a measure of material reward, or who in scholastic seclusion may have a conservatism born not of the rebuffs of industrial competition but of an obsession that organized study of the material problems of a class either is superfluous or is provided by a college fraternity, or who fear to espouse a cause they know is good because it might alienate the good will of the few who for industrial reasons do not approve of it.

We are concerned here with the formation of a professional organization of chemists dedicated to the inculcation of standards of capacity and to the study of the material problems of the chemically educated workers of industry and to the development of the potentialities of such men as citizens. We wish to emphasize the virtues of such an organization the need of which generally is conceded but about which there is difference of opinion as to its prospective status.

During the year closing with this number of CHEMICAL AGE we have discussed this subject with a frankness and fullness that have made friends all over the world, with the result that our opinions are not peculiar to us but reflect those shared by thousands of educated chemical workers. Commendation of our discussion of this subject has come from all parts of the

* In Chemical Age, Vol. 29, 1921, the subject of the American Institute of Chemistry has been discussed as follows: American Institute of Chemistry. Observations on the Project and Answer to the New Jersey Chemical Society's Questionnaire, I 22; American Institute of Chemistry. Additional Observations on the Project of an Economic Organization of Chemists, II 50, III 95, IV 127, V 90, VI 225; American Institute of Chemistry. Some History of Chemical Organization in Great Britain and Some Comparisons, VIII 301; American Institute of Chemistry IX 369, X 432, XI 470.

country, often with the singular confession that they themselves would like to say it if material considerations would permit it.

This situation we characterize as one contributing powerfully to discontent, viz., that conscientious chemical workers refrain from discussing openly the material problems of their profession for fear of alienating the good will of those who sit as sentinels at the approaches to consideration and preferment in association activities.

It is true that we are confronted at present with the condition of more men than jobs, but this should serve to emphasize the necessity of an organization devoted to the study of the preparation of chemists, their reception in industry and their distribution, utilization and growth. Although chemists ordinarily do not come in contact with the public, their embracing science and multiform arts give them such intimacy of contact with all aspects of life that a civic potentiality as educators is emphasized by its neglect.

We have discussed briefly some salient aspects of the growth of associations, and believe that an economic organization of chemists has no place within the embracing confines of a hypertrophic society. Its scientific purpose, occluded functions and machinery of government are for reasons already stated incompatible with those of an organization designed to make the most out of chemically educated men by studied cooperation with the law of natural selection.

Such work finds its logical boundaries along state lines and buttressed in state chemical societies, with a responsibility on one hand to the people of the respective states in the performance of necessary educational and statistical functions and on the other, to the state section of the American Institute of Chemistry whereby chemically educated men aim to measure up to standards of capacity that they themselves inculcate.

Aside from the primary need of the development among chemists of a professional consciousness, they need experience in the work of organization and the recognition of the fact that making good in an industrial plant is only a part of their responsibilities as citizens. These opportunities are provided in organizations that they themselves create and manage, with results that will be reflected in the rivalry of similar organizations in service to their communities and to themselves—all coordinated by inter-communication, whereby each individual may find the place in industry best suited to the development of his capacity, and serving effectively as the bridge for the technical novitiate between the university and industry.

When we realize how momentous is the graduate chemist's first job in its influence upon his subsequent career; when middle-age enforces upon us the conviction that the turn of 35 gives us the measure of the man, we know that men who love their kind will see in the type of chemical organization that we have outlined the greatest practicable instrumentality yet proposed for the elimination of waste among the professionally trained human element of chemical industry.

Industry develops only as its administrative and creative genius improves. With the high-class human raw material represented in the expensively produced chemically educated men who 10, 15, 20 years hence will be among our industrial leaders, it is reprehensible that they be turned loose in increasing numbers into industry to lodge where they may and to stick as they will and to serve as they can, without some organization to whom they can turn as a matter of right for service to be rendered as a matter of duty.

Notwithstanding that natural law is the norm in all human relations, the ambitious industrial chemist today

demands to receive the bread of sympathetic practical helpfulness and not the stone of bureaucratic indifference. This helpfulness he and his fellows alone can create; it never will be done for them.

Frankly, it should not be done for them, for chemists as a class need the experience incident to the creation of such an instrument of service. To do things for people too often not only is a thankless task but of doubtful advantage. Growth comes only from exercise.

Doubtless because of the conditions of development of American chemical industry and the peculiarities of its educated personnel, are the oligarchical aspects of association activity in chemical work so conspicuous. Broad-minded men who put men above methods and whose experience teaches them that the thriftiest and most helpful growth in activity of the kind we are discussing is from the bottom up and not from the top down, see that present desires and tendencies in chemical segregation are from feudalism to democracy.

This tendency is not a forced procedure. It is natural. It repeats in a class, in miniature, the experience of the race and enforces the conviction that the tendency being sound should be encouraged. For men from personal motives to discourage it, or for a group to resist realignment with natural law or to oppose others who desire organization in conformity with it, has, if not futility, for its reward, at least the barren satisfaction of nullifying natural growth.

Already has been discussed* the present analogy of American conditions as regards the attitude of existing organization towards the proposed American Institute of Chemistry, with those in Great Britain 40 years ago when the Institute of Chemistry of Great Britain was organized under the presidency of Sir Edward Frankland, theretofore president of The Chemical Society which was the embracing chemical organization of the time.

We emphasize this analogy and the courageous confessions of mistaken attitude on the part of Englishmen prominent in chemical work who were conspicuous in their opposition to an economic organization of chemists, not to present the British Institute of Chemistry as a pattern to be copied but as a precedent to be respected.

We deplore the narrow vision of chemical bureaucrats who would sacrifice the welfare of chemically educated men to methods and to a system illy geared to American economic conditions.

The functions of the proposed American economic organization of chemists are incompatible with those of a national educational society of catholic membership. The American Institute of Chemistry would be a state organization, with federated relations with organizations of identical functions in other states, which may be considered as the sublimation of capacity of chemists, organized with all identified with chemical enterprise in the respective states in the form of state chemical societies. This type of organization provides on the one hand for the recognition of chemical capacity and on the other for opportunities whereby the widely variant chemist may find the best market for his talent.

With the expansive development of chemical enterprise in a realm unmatched in diversity and richness of chemical resources and in volume of its present and prospective professionally trained personnel, the conviction is general that existing chemical segregation in America is out of step with and deplorably unresponsive to the needs of the time.

The state chemical society would gather unto itself all those identified with chemical enterprise within the state and would qualify to act as an arm of the state in

*CHEMICAL AGE, August, 1921, pp. 301-304.

the development of this basic industry, and to cooperate with the educational institutions of the state in the promotion of the training of men to serve chemical industry and of their growth after induction into the industry.

Membership in the American Institute of Chemistry would be recruited from the capacity in the state chemical society and would receive the seal of approval for ability to serve industry and through it the people.

Aside from its basic indispensability to industry, when we consider the fundamental and intimate relations of chemistry to society, who has the temerity to say openly that our discussion is fanciful?

Myopic vision and fond regard for things as they are declare that such organization as we have discussed is disruptive and destructive. To such we commend the perusal of the article in *CHEMICAL AGE*, August, 1921, entitled "American Institute of Chemistry—Some History of Chemical Organization in Great Britain and Some Comparisons." Has chemistry reached the limits of its growth? Is the cup of its service to mankind drained? Is human curiosity satisfied and have the wants of man attained their apogee?

Our convictions have their roots in chemical education, in experience in every department of chemical industry and in a knowledge of men and things and ways and means and in an optimism and a measure of discernment that have little patience with men not big enough to see that the more they help others the more they help themselves.

We know the increasingly drastic requirements of chemical professional education; we know the mental processes of the chemist; we know his limitations and his potentialities; we know the discipline of the plant and the rivalry of capacity; we appreciate the ambitions of chemists in the work of production, and realize as one of the kind who has been through the mill the archaism, inadequacy and lack of class instruments of service designed to promote his material welfare, desirable analogous forms of which in successful service exist all about him in fields whose intellectual requirements are inferior to those of his own.

Restrained not by the inhibitions of bureaucracy and keen to help chemists make the most out of themselves by pointing out the most effective way in which they can grow, which is self-exercise, we submit again the American Institute of Chemistry to the chemically educated men of America.

The American Mining Industry

In the accompanying table is a summary of American enterprise in the extraction of non-agricultural wealth from the earth. What the reader visualizes here is "metallurgy and mining," but it is fundamentally chemistry. The Census Bureau's summary of the chemical and allied industries, *CHEMICAL AGE*, Vol. 29, p. 208, showed the extent of industry based upon the utilization of these inorganic raw materials.

This statement of results of the 1920 Census of mines, quarries, and wells covering the year 1919, embraces statistics of the number of enterprises, number of individual mines, quarries, and petroleum and natural-gas wells operated, average number of wage earners employed, total horsepower used, and value of products for the producing enterprises in the mineral industries.

These statistics cover only enterprises that were productive, with an output valued at more than \$500, or, in the case of bituminous coal mining industry, amounting to more than 1,000 tons of coal. The term "enterprise" represents one or more mines, quarries, and wells or groups of wells or natural-gas-gasoline plants, all

within the same state, operated under a common ownership or unified control, and for which a single report was secured. The enterprise is further defined as being limited to a single mining industry.

The statistics on power used represent the total horsepower of prime movers used by the enterprise plus horsepower of other equipment, principally electric motors operated by power purchased. The figures represent rated capacity of engines, motors, etc., and not the amount of power in actual daily use.

The value of products reported is the value f. o. b. mines, quarries, or wells, etc., of materials produced during the calendar year including receipts for mineral and other unspecified products, for custom milling, power sold, and work or miscellaneous services for other enterprises.

CENSUS OF MINES AND QUARRIES, SUMMARY FOR THE UNITED STATES, BY INDUSTRIES: 1919.

	Enter- prises.	Number of quarries or wells.	Wage earners (average number).	Power (horse- power).	Value of products (\$'000 omitted).
All industries.....	21,280	981,560	6,723,786		\$3,158,463
Fuels—					
Coal:					
Anthracite.....	254 ²	534 ²	147,372	899,783	\$364,084
Bituminous.....	6,636	8,316	545,798	2,135,412	1,145,977
Petroleum & natural gas.....	9,814 ³	260,675 ³	96,265	1,821,342	991,793
Metals—					
Iron ore.....	290	472	45,741	370,889	218,217
Copper ⁴	195 ⁵	226	43,717	523,591	181,258
Gold and silver:					
Lode mines ⁶	740 ⁶	799	15,436	149,680	58,832
Placer mines.....	112	132	1,380	25,632	9,398
Lead and zinc ⁷	432 ⁸	473	21,884	229,541	75,579
Manganese.....	35	57	969	5,880	2,188
Quicksilver.....	23	26	748	2,607	1,803
Rare metals ⁹	22	22	633	3,544	1,725
Stone—					
Basalt.....	163	174	3,396	37,397	9,657
Granite.....	358	381	8,049	85,674	18,297
Limestone ¹⁰	895	925	22,069	213,717	52,943
Marble.....	48	62	1,732	15,628	4,397
Sandstone.....	255	276	4,287	33,869	10,684
Slate.....	101	104	3,513	20,613	5,720
Miscellaneous—					
Abrasive materials ¹¹ ..	34	34	317	1,748	721
Asbestos.....	10	11	146	420	249
Asphalt.....	9	12	324	618	749
Barytes.....	89	98	919	3,029	1,592
Bauxite.....	10	15	738	2,507	2,190
Chromite.....	15	16	61	196	165
Clay ¹²	344	349	5,442	21,218	10,033
Feldspar.....	34	34	178	284	103
Fluorspar.....	54	72	1,124	7,138	3,334
Fullers earth.....	9	9	824	2,538	2,019
Graphite.....	21	24	419	6,410	869
Gypsum.....	17	48	2,191	15,032	6,805
Magnetite.....	11	11	448	2,540	2,160
Mica.....	65	69	448	803	697
Millstones.....	11	11	37	220	64
Mineral Pigments.....	23	23	185	1,630	480
Phosphate Rock.....	48	69	4,373	49,639	10,300
Pyrite.....	17	18	1,172	7,338	2,408
Silica.....	25	30	177	2,037	404
Sulphur.....	4	4	1,129	15,291	17,935
Tals and Soapstone.....	28	30	958	7,053	2,302

¹ Pennsylvania only.

² Operating units or "collieries" embracing mines and breakers, also washeries and river dredges.

³ "Plants" embracing 374 mines, 79 washeries, and 81 dredges, but not counting 245 breakers operated in connection with mines.

⁴ Includes natural-gas gasoline: 1,117 plants.

⁵ Productive petroleum and natural-gas wells, December 31, 1919.

⁶ Includes reduction mills operated in connection with and independently of mines, and operations on old dumps and tailings.

⁷ Includes antimony, molybdenum, tin, titanium, tungsten, uranium and vanadium.

⁸ Not including enterprises producing limestone for their own use at the quarries in the manufacture of lime.

⁹ Includes enterprises producing emery, garnet, pumice, tripoli, diatomaceous earth, stone for hones, scythesones, whetstones, etc., and tube mill pebbles and liners.

¹⁰ Does not include enterprises producing clay for their own use at the mines in the manufacture of clay products.

William H. Cady, chief chemist, U. S. Finishing Co., Providence, R. I., has been instrumental in the establishment of the Rhode Island section of the newly-organized American Association of Textile Chemists and Colorists.



Eastern Half of Campus, Canton Christian College, as Viewed from the Hongkong Steamer

Applied Chemistry in China

A Description of Chinese Practice of Industrial Chemistry and of the Service of the Canton Christian College in Training Chinese Chemists

By Clinton A. Laird

Professor of Chemistry, Canton Christian College

THE chemist finds in South China an almost infinite variety of interesting fields in which to work, with very little scientific work done in most of them. Besides the rich mineral resources, which are both widely scattered and of considerable variety, the subtropical climate has been favorable to the growth of many trees and plants which have produced a wide variety of raw material ready for commercial utilization.

Many of these raw materials are somewhat developed, but by processes which are simple and too often wasteful. In some cases these processes will appeal to the person with antiquarian tastes, for they have been in operation unchanged for centuries. Generation after generation has been satisfied with the methods which their forefathers developed empirically and proved would give a fair measure of success. Little experimentation has been done and few have dared to depart from the beaten path.

The industrial chemist and chemical engineer find many workmen with skillful hands, careful of details, and not wasteful of materials which can be seen, but ignorant of causes and with no comprehension of the losses which may take place in solution or as vapors. The economic losses therefore are very great.

All native industrial operations are conducted on a small scale. If machines are used they must be simple to operate, and the first cost must be low. A few of many possible illustrations follow.

Oil Extraction

Many thousands of tons of peanut oil are consumed annually. The nuts are crushed by "drop-hammer" mills. The equipment is simply a large hammer supported on a fulcrum near the end of the handle. The head is raised by men throwing their weight onto the handle. When they step off, the head falls onto the pile of nuts. Labor is so cheap that this can compete successfully with steam-driven crushers! In other place beans and wood-oil nuts are crushed by a heavy wheel turning in a stone trough. A typical one is circular, fourteen feet in diameter, five inches wide and five inches deep. The wheel is on one end of a shaft which is attached at the other end to a post, free to revolve, in the center of the circle. A pony or buffalo cow, harnessed to the shaft, furnishes the power.

Wooden wedge presses, which are cheap to purchase

and operate, are commonly used. They can compete in efficiency with the much more expensive hydraulic presses because the cake is left under pressure for nearly twenty-four hours, and labor is cheap.

Valuable products like aniseed and cassia oils are obtained by steam distillation using the crudest of stills. They are made of small units, easily assembled and taken apart to recharge, but the joints are loose and generally sealed only with a wet cloth! The condensers are a marvel of inefficiency. The cassia oil stills ordinarily recover only half of the oil which could be recovered by modern methods. After a "run," the leaves and twigs are taken from the still, dried, and later used as fuel under the still. At prices ruling last summer the oil was sold at cost, and the profits came from the sale of the ashes which are rich in potash.

Ferrous Metallurgy

Blast furnaces only six feet high, using wood charcoal instead of coke, tipped over to pour the metal and yielding about seventy-five pounds of iron every fifteen minutes, sounds like a joke, but they are not uncommon. From the iron obtained this way the pans which are used in every household and in many industrial processes are cast. These pans range from thirteen inches to four feet in diameter, and the metal varies in thickness from less than one-sixteenth of an inch in the smallest to one-eighth of an inch in the largest.

Tanning

A recent visitor, familiar with the tanning industry in Japan, stated that that country has no workmen who have the skill to split a hide by hand, and marveled at the way that the Cantonese workmen were doing it. Unfortunately the native processes of making leather are slow, and spoil good hides to make very poor leather.

Soap-Making

Several small soap factories have been started recently in Canton, making laundry soap by formula. They have no way to determine the quality of the ingredients, or of their product. Making only a few hundred pounds at a time, of which none is pure, and no two lots are alike, some of it might even make a skilled soap maker blush with shame at what is offered the unsuspecting public as soap, but all of it seems to find a market.

Instruction in Industrial Chemistry

There are an increasing number of students who wish to be trained to develop and utilize properly their country's resources. With equipment capable of operation on a small factory scale, in part made up of units which may be used in more than one process, it will be possible to give these students first hand experience in typical chemical industrial processes.

One of my ambitions is to be able to take the peanuts raised on the College farm, press out the oil (and make a careful comparison of native methods with an hydraulic press), supply the school kitchens with a better grade of oil (cold-pressed) for cooking than is ob-



Chemistry Lecture Room, Canton Christian College

tainable on the local market, and use the hot-pressed oil for making a "Ling Naam" soap. Some of the other processes which can be carried through here would be the making of bleaching powder or even electrolytic chlorine to purify our water supply; the proper expression of China Wood oil and its treatment for varnish; scientific steam distillation for obtaining essential oils like cassia, aniseed and camphor; the tanning of leather; and a small kiln for making better earthenware than is made at Shek Waan, twenty miles away, by the process which has been in use for hundreds of years.

Industrial Research

As a preliminary to a part of this work a survey has been begun of the resources of South China in oils, both of the class of peanut, rape, tea-seed and China wood oils, as well as the more uncommon cassia and aniseed oils. It seems probable that two, not yet reported as produced in China, have been located, with the chances in favor of others being found, as the work goes on.

But the attractive fields of work here are not all in the industrial fields. No study has been made of the river water here, with its possible relation to some common diseases. An agricultural chemist will find soils which never have been analyzed, and a host of agricultural products which have not been studied. Who could ask for a larger or more attractive field than the study of the Chinese pharmacopoeia, or who knows what new compounds might be isolated from its strange herbs?

One of the fields that has been hardly touched in China is the study of Chinese foods. There are dozens of articles of which no accurate analysis has been made. Nothing is known as to their food value in definite terms. The fact that millions are living on these, and the more common foodstuffs, does not outweigh the facts that many are suffering from the effects of malnutrition, and that many children suffer and die be-

cause of their parents' ignorance of how to make proper use of the foodstuffs available.

Common knowledge has produced queer ideas as to what may or may not be eaten on various occasions. For example, one with a cold should not eat chicken, with cancer goose, or with malaria peanuts; but a tubercular person should drink Peking ink; eating beans or bean soup and dog meat or honey and bean curd at the same meal will cause death!

Feeding experiments are now being carried on with a colony of over sixty white rats. On some food combinations some are growing faster than the normal rate of growth in Western countries, which argues well for



View of a Chemical Laboratory, Canton Christian College

local conditions. It is hoped by this work to aid in translating into terms of Chinese foods what has been and is being learned in England and America regarding the principles of nutrition, to prove the value of these foods, thus enabling doctors and dietitians to choose wisely in both sickness and health, and also helping introduce to other countries the good things which China has.

The biological chemist has not only a wide field in which he can work without encroaching on the spheres of other workers, but nowhere else in the world will he find a greater need for information on nutrition. The effect on the health and happiness of millions of people will be incalculable, when such information is both available and put into terms that bring about its adoption.

Henry Joseph, Ch. E., 1921, Columbia University, is engineering assistant to Charles A. Lunn, chief chemist, Consolidated Gas Co., New York City.

* * *

Japanese chemical industries are showing a willingness to combine with foreign concerns. Two such arrangements have been announced. The Japan Chemical Fertilizer Co. has arranged a 5-year contract with the Brunner Mond Co., of England, while the Kanto Oxygen Co. has made an agreement with the Samuel Co. The Japanese concerns are to manufacture goods under processes supplied by the foreign firms, and are to be assisted in obtaining the necessary materials. The domestic chemical industry has apparently found itself, in some lines at least, unable to maintain its hold on the home market and has taken the above course as the best way out of the difficulty. The worst depression, however, is felt by the dyestuff manufacturers, who, unless something is done for them, are faced with the prospect of seeing German imports capture the entire market.—*Commerce Reports.*

Creating New Uses for Rubber

THE success that has attended East Indian production of plantation rubber has reacted to the demoralization of the crude rubber industry in that production of plantation rubber, which in 1914 overtook the "wild" variety of Brazilian origin, now constitutes over 90 per cent. of the raw rubber supplies and far surpasses present consumption demands.

Increased consumption in present uses and the development of new uses of rubber are subjects of increasing concern with English investors in rubber plantation companies which control about 80 per cent. of the plantation rubber business. This is reflected by a writer in the London *Times Trade Supplement*, who says that the primary object of the rubber propagandist is to increase the demand for the raw material. It is obviously desirable that the utilization of rubber in quantity should be extended to as many purposes and spread over as many industries as possible, otherwise the fortunes of rubber growers will remain dependent on the development of the automobile industry, as is the case at the present time to a very great extent. This restricted use constitutes one of the weakest points in the whole position.

In these circumstances the consideration in its broadest aspects of the question as to the direction in which propagandist efforts are most likely to achieve the purpose desired must take cognizance of three sets of data, viz., (1) the rubber retained for probable consumption, (2) the purposes for which rubber is used, particularly in the United States, the greatest consuming region, and (3) the annual *per capita* consumption.

As to the amount of rubber now retained for probable consumption reasonably accurate figures are not available; for 1920 they were given approximately as 248,800 tons for the United States, 57,000 tons for Great Britain and 16,600 tons for France. In the uses of rubber, automobile requirements are in the forefront with over 70 per cent. of all rubber produced, with mechanical rubber goods, boots and shoes, insulating materials, waterproof cloth and sundries making up the balance.

Of especial importance in the consideration of increasing the consumption of rubber, is its present annual *per capita* consumption, which is submitted as follows for the chief commercial nations:

	lbs.
United States	4.15
Great Britain	1.48
France	1.00
Italy	.50
Germany	.36
Japan	.35

Where Can Increased Consumption of Rubber Best Be Promoted? Backward Countries

The first point which naturally arises in considering these factors is as to whether attention in the first instance can be directed more advantageously to increasing the *per capita* rubber consumption in the more backward countries, in order to bring it nearer to the comparatively high level reached in the United States, or whether it would be preferable to concentrate attention on still further developing demand in the latter country as being the world's largest and wealthiest consumer. This is a question which certainly merits examination before money and energy are expended in either of the directions indicated.

On broad lines it would appear that the comparative wealth of the United States, as opposed to the relative poverty of the rest of the world, would be a more or less

determining factor. Yet in the United States the purchasing power of the masses of the people, by reason of the stagnation of trade and to some extent on account of profiteering, has been poor, and rubber has suffered like other commodities. It would therefore seem questionable whether the accumulated wealth of the United States necessarily makes that country a better field for the rubber propagandist than the poorer countries of Europe, where so much leeway remains to be made up.

If other things might be considered as equal, it would, in the writer's opinion, be a very open question as to which would be the better direction for rubber propagandists primarily to devote their attention. There are, however, other matters of considerable importance which certainly must not be overlooked, and which probably will prove the determining factors.

To begin with, it may not unreasonably be assumed that the general standard of living in the United States is higher than elsewhere; higher than in Great Britain or France, much higher than in Italy, and infinitely more so than in the case of Japan. This in itself is an exceedingly important matter. The higher the standard of living, the greater the amount of rubber consumed *per capita*. The fact that the United States consumes at such a high rate for each member of the population is greatly due to the enormous development of the automobile. This does not, however, tell all the story. The progressive spirit of the American people is certainly a very important factor. As a nation they are at the present time far more likely to go ahead quickly with new suggestions and new uses than any of the older nations.

Probably the weakest factor in the position of rubber growers to-day lies in the fact that three-quarters of the consumption of raw rubber is for tires. It is very improbable that any efforts which we might make would prove effective in materially increasing the uses of tires, and all our endeavors should certainly be directed towards greatly increasing the demand for rubber in other directions, so that the prosperity of the industry is not so entirely governed by the course of automobile developments.

In point of fact, it is also interesting to note that in past years of prosperity American tire production has been so enormous, and its growth so rapid, that the large manufacturers have been inclined to concentrate upon the tire business and not push the minor lines. The recent check in international trade has lessened this tendency, and American rubber manufacturers as a whole are now said to be very keenly searching for new uses capable of profitable exploitation. The promotion in America of increased uses for rubber would comprise:

(1) The distribution of the printed list of suggestions for new uses for rubber which have resulted from the recent Rubber Growers Association prize scheme.

(2) The introduction to the American boot and shoe trade of raw rubber soles.

(3) The endeavor to interest road-building authorities in the possibilities of rubber for roads, and to induce them to experiment in the same way as has been done in England.

(4) The introduction of rubber platforms in American railway stations.

It is concluded that America should be the most important field of the rubber propagandist's operations, and that the efforts now being made in England should to some extent be regarded as experimental, in the sense of feeling the way in the small pastures before venturing into the broad acres of the world's largest customer for the produce of the rubber tree.

Some Phases of Chemical Cost Accounting

C. B. E. Rosén, M.B.A., C.P.A.

Charles F. Rittenhouse & Co., Boston, Mass.

COST accounting in the chemical industry presents many interesting phases of both process costs and production order costs. This article, however, deals chiefly with process costs. In some classes of chemical plants the process cost system is the prevailing type of cost system; in others, the production order type. Since some of the detailed work in the cost department of any business is more or less similar, such work is not described in this article but only the principal features of the cost accounts in a chemical concern.

In a chemical plant the cost accountant should furnish such principal facts as the following: The cost of converting the raw materials, the manufacturing overhead, the manufacturing cost in bulk, the factory cost of the product packed or otherwise prepared for shipment, and the selling cost. Such problems as by-products, repairs, depreciation, obsolescence, overhead and its distribution, and containers also should be considered.

In a large chemical concern the work of the cost accounting department may be sub-divided advantageously between the factory and general offices, the former having to do only with quantities of materials, supplies, productions, shipments, and inventories, and in the value of labor; and the latter having to do with the values of the quantities reported by the factory office, and the summarized labor charges. This requires the perfection of a system of prompt inter-office reports. For smaller companies, this sub-division may be unnecessary.

Another purpose is to discuss this subject with a view to providing monthly costs, which are desirable. However, figures covering a longer period of three or six months are likely to prove more reliable, due to the variable conditions arising in the production of chemicals.

Peculiarities of Chemical Cost Accounting

The manufacture of chemicals requires a diversity of products and chemical strengths which makes it impossible to have complete uniformity in the cost data. A chemical plant is divided into departments, each one manufacturing a distinct product, generally in its own special building with its own equipment. The cost records are kept by departments.

Owing to the relationship of some of the basic chem-

icals to the minor products, a material fluctuation in a basic chemical may affect very decidedly the cost figures of the other products. Many products are manufactured in groups, that is to say, the production of one major product may involve one or more other products which may be manufactured either in separable steps in a continuing process, or as by-products. The cost of manufacturing the separable steps in a process can be ascertained usually, but the cost of manufacturing by-products cannot be determined accurately. Therefore it is accounted for on an arbitrary basis.

The value at which by-products are brought into the cost accounts varies in accordance with the effect which the management may desire on the cost figures of the principal product, which in turn may affect the costs of several other products. By-products are accounted for as produced. Furthermore, the unit of measure and the degree of chemical strength varies between the different products. The units of measure may be either gallons, pounds, hundred pounds, net tons, or gross tons, and products may be quoted on one basis on the market and their costs recorded on another basis.

These facts of course do not vary the elements of cost, but they do make the unit cost figures of variable meaning. In the case of major products manufactured in different strengths this condition is remedied, however, by the use of chemical factors.

Cost Sheet

The accompanying blank is a form of cost sheet for monthly reports of manufacturing cost in bulk, which can be adapted to a columnar cost ledger, so as to show comparative monthly costs on the ledger.

This form of manufacturing account, as well as subsidiary accounts for raw materials, supplies, manufacturing expenses, finished goods and sales should be kept in a factory ledger and controlled by the general ledger.

In many non-chemical concerns such items as power, fuel, supplies and repairs are generally considered as overhead, and not as direct costs. In a chemical plant, however, where each product for all practical purposes is an independent manufacturing unit, these items are considered as direct operating costs in converting

Manufacturing Cost of _____ Month of _____ 192_____		Amount	Cost per Unit of Measure Produced
<i>Raw Materials:</i>			
_____	Pounds @ _____	\$.....	.....
_____	_____		
_____	_____		
_____	_____		
		\$.....	
<i>Less: By Products</i>		.....	.....
<i>Net Cost of Raw Materials:</i>		\$.....	.....
<i>Conversion Cost:</i>			
Labor	.....	.....	.....
Power, Light & Heat	.....	.....	.....
Fuel	.....	.....	.....
Supplies	.....	.....	.....
Repairs	.....	.....	.....
<i>Total Conversion Cost</i>		\$.....	.....
<i>Shop Cost</i>		\$.....	.....
<i>Overhead Expense:</i>			
Taxes	\$.....	.....	.....
Insurance	.....	.....	.....
Depreciation	.....	.....	.....
Works Expense	.....	.....	.....
		\$.....	
<i>Less:</i>			
Loss from Idle Plant	.....	.....	.....
<i>Overhead Chargeable Production</i>		\$.....	.....
<i>Cost in Bulk—Quantity</i>		\$.....	.....
<i>Yield—_____%</i>		.....	.....

the raw materials into the desired finished chemical. Power is used in stirring or heating the contents of the large mixing tanks, or for refrigeration in other cases. Fuel is used for heating, evaporation, distillation and calcination in their varied forms in chemical manufacture. Supplies, such as water and sundry items, are necessary. Repairs to the buildings and apparatus also are constantly necessary owing to the often rapidly deteriorating influences of the materials used.

Raw Materials

Raw materials are purchased either in a state ready for immediate consumption, or in a state which requires grinding, drying or other treatment before they are suitable for use.

A record of all materials received is kept in the receiving department and reported to the cost department, and should correspond with the quantities shown on the invoice after adjusting the differences between the invoice weights and the receiving department's weights.

Separate accounts properly controlled are kept for each raw material in quantity and amount. In these accounts all charges such as invoice cost, inward freight and hauling, containers, duties and insurance, and handling charges are accumulated; as well as credits for salvaged incoming containers, for materials lost due to evaporation, and similar items which affect the cost of the raw material delivered at the plant.

If the raw material must be ground or otherwise treated and such treatment is of sufficient volume to make it practical, it is accounted for separately as a distinct process. The separate accounts show the original material, the cost of grinding, or conversion, which would include labor, power, supplies, and repairs, and a proportion of factory overhead. This separate information is of value when comparing the cost of the raw material treated at the factory with the cost of purchased material suitable for consumption when received.

Containers

Brief mention might be made of the relation of incoming containers to the purchases of raw materials. Raw materials are received in bulk, or in containers, such as bags, barrels, carboys, drums or cylinders. These containers may be either non-returnable or returnable. Non-returnable containers are charged into the cost of material. It may or may not be advisable to separate returnable containers from the cost of the raw material. In the case of bags, for instance, the number which can be salvaged is not always easy to determine. In such a case it is more practical to charge them into the cost of the materials, and credit them out when salvaged. Returnable containers which are easily separated are charged direct to "Containers Returnable to Vendors." This latter account is also charged with returnable containers formerly charged into the material cost when they are salvaged, at which time a credit is made to the raw material account.

When all the proper charges to raw materials for the month have been recorded on the accounts, the raw materials used during the month must be charged out, as well as any losses sustained. In order to do this, a report of the monthly consumptions and of any losses

which may have occurred must be obtained. This report can not always be prepared accurately and in detail. Materials handled in small quantities are easily accounted for. Materials handled in large quantities, however, necessitate the use of the best estimates that can be obtained.

Owing to the fact that a chemical plant is generally spread out over considerable territory, in the interest of economy, raw materials handled in large quantities must be received and stored at a point which is the nearest practicable one to the place of consumption. From a practical standpoint, this condition does not always permit a constant watch over all the raw materials in order to obtain detailed accuracy in the recording of quantities used.

As the materials are consumed they are measured and reported, or, in some cases, they may be taken without any record being made. In the former case daily records of quantities consumed are kept and summarized monthly. In such cases where no record is made of each withdrawal from stock the monthly consumptions must be arrived at by deduction.

This procedure also is followed in testing the monthly consumptions of those materials for which daily reports of withdrawals from stock can be obtained.

The closing book inventory is tested with the actual inventory as often as possible. The consumption of large quantities cannot be measured exactly. Consequently, this periodic test of inventories is necessary to avoid large errors, and the consequent adjustments.

Where the difference is not of consequence and is not due to causes, such as evaporation or dissolution, it can be distributed over the departments using the raw material on the basis of consumptions.

At the end of each month the works accounting department reports to the cost department the amount of the different raw materials on hand at the works, stating the amount in quantities of the opening inventory, purchases, consumptions, adjustments, losses, and closing inventory. The opening inventory, purchases, and sales should reconcile with the general books.

The credits for amounts consumed or lost are then recorded in the books and charged to the proper accounts at an average price arrived at by dividing the amount of the opening inventory plus the total cost of the purchases during the month, by the total of the quantities of each of the above items.

By-Products

The production of by-products absorbs labor, power, supplies, repairs and factory overhead, but these costs often cannot be ascertained and apportioned accurately. The main products should receive credit for the by-product, as produced, but the value is generally arbitrary, and depends in most cases upon the showing desired in the costs of the main product, and upon market conditions. However, a uniform practice must be adopted and followed consistently, and the method of valuing the by-product must be a conservative one.

There is a difference of opinion as to whether the value of the by-products is a credit to the raw material cost, or to the total manufacturing cost of the main product in bulk. It would seem more logical that the by-product credit should be applied to the total manufacturing cost rather than to give a single element benefit for the entire value, because the former cost includes the other elements of labor, power, repairs, depreciation, and overhead, although its amount is arbitrary.

On the other hand, it is desirable to show the raw material cost at a figure which might be compared

The National Association of Cost Accountants, 130 West 42d Street, New York, in its educational service of directing attention to the importance of accurate and uniform methods of cost accounting, is publishing a series of cost studies in the various industries. The study relating to the chemical industry, Vol. III, No. 6, issued December 1, is the basis for the above article which will be concluded in January, 1922.

with the price of the material, after the by-products are extracted, on the theory that the main product should absorb all production charges, and that the by-product value should be based on material cost only. This question is one which affects merely the presentation of cost figures, because the total manufacturing cost of the product is not changed by either method.

Conversion Cost

When the raw material has been prepared for consumption the next step is to convert it into the finished product, which require labor, power, fuel, supplies and repairs. These costs are grouped as elements of "Conversion Cost."

Productive Labor

When one visits a chemical plant, the scarcity of laborers is very evident, because many processes are run without interruption and mechanical devices are used to a very great extent. The labor required by various processes depends upon the mechanical devices available and the importance of the product. The handling of materials and finished products requires the largest percentage of the labor, the other operations being performed by a few skilled chemists and foremen.

In order to arrive at the direct and indirect labor costs the time clock cards are extended and summarized weekly by employees and by departments. The summary is made on sheets which provide for monthly totals. From this record, a monthly report of payroll distribution can be prepared. This report serves as a basis for a monthly journal entry distributing the labor charges for the month.

The transfer of materials from their storage place to the department where they are to be used may involve the expenses of handling by teams within the yard. This expense is a cost to be added to the labor cost, although not included therein when distributing overhead. The total cost of operating yard teams is kept in a separate account, and distributed monthly on the basis of the work reported done by the teams.

Power, Light and Heat, and Fuel

A considerable amount of power and heat is required for the treatment of materials in their conversion into the finished product. If an independent power plant is maintained, the cost of the power produced will be represented by the cost of operating the power plant. From the meter readings, the power produced and the power consumed in the various departments can be ascertained. The power cost is distributed on the basis of the report of those readings. If the power is purchased outside, the necessary readings of power purchased can be obtained from the invoices. Power used in the various departments may be ascertained from meters installed in those departments, or if no meters are installed in the various departments the best possible distribution must be used. The manufacture of some chemicals requires the use of large furnaces involving large expenditures for coal or fuel oil. Fuel is generally purchased in large quantities and charged out as it is used. The cost of each of the various kinds of fuel is kept in separate accounts, both in quantity and in value, similar to a raw material account. The quantities used are charged out at average unit costs.

Supplies

The supplies used in and about a chemical plant are quite numerous, depending upon the size of the plant.

A perpetual inventory of the supplies in the storehouse should be maintained. At the end of each month, a report of requisitions filled should be prepared. The total expense of operating the storehouse for the month should be ascertained. This storehouse expense should then be distributed on the basis of the value of supplies requisitioned, and the combined value and expense should be charged as the cost of supplies used in the various departments.

Any supplies not under storehouse control, should be kept in accounts similar to the raw material accounts and should be charged out to the various departments when used, as per reports thereof, at an average unit cost.

Repairs

The chemical action of the products on the machinery and buildings necessitates frequent repairs. It is difficult to anticipate the extent of these repairs in the course of a year with any degree of accuracy.

These repairs, as well as that portion of any replacements which do not add to the value of the equipment as it was, prior to the replacement, are proper charges to costs and, on account of the departmentalization of the plant by products, are directly chargeable to the products. Their occurrence, however, is not constant in amount, so that if they were charged direct to costs as they occur, the monthly cost figures would be disturbed. Therefore, in order to spread the item of repairs evenly over the monthly cost figures, an amount is set aside each month as a reserve for repairs, and the actual expenditures when made are charged against that reserve.

A careful study of plant conditions and past experience will enable the cost department, in co-operation with the factory engineers, to arrive at a fairly close estimate of anticipated repair charges for the year by departments. Monthly journal entries should then be made charging one-twelfth of the estimated necessary reserve to costs and crediting the reserve. If a department is not operating for a whole month, it is assumed that it will not necessitate making repairs, and consequently no reserve it set aside.

The actual outlay and the reserves for repairs must be watched closely, because it may be found necessary to adjust the monthly reserve charge, during the course of the year, in order to take care of unexpected repairs. The difficulty in anticipating repairs makes it desirable, as well as conservative, to adjust the reserves to the actual expenditures, in the last month's cost figures, of each year. This adjustment should appear as a separate figure so as to aid the comparisons with former months. This procedure will result in annual cost figures which are based on actual repairs and does not require the carrying forward on the balance sheet of a deferred debit or deferred credit of questionable value.

Overhead Expenses—Taxes

The segregation of overhead expenses, as set forth on the cost sheet on page 501 shows four items, namely, taxes, insurance, depreciation and works expense. Taxes and insurance are handled in the usual manner.

Taxes are distributed on the basis of the values in the various departments as shown by the records of plant values.

Fire and Liability Insurance

Liability insurance, especially workmen's compensation, presents a problem, when distributing the expense thereof to costs, owing to the diversity of operations which may be covered under a blanket rate. The dis-

tribution of this expense to costs can best be done in the light of the conditions stated in the policies obtained but if those conditions are too involved an average rate may be used. As the premium for this insurance is based on payrolls, the distribution of the premium is based on the cost of labor.

For those plants where insurance, especially against fire, is hard to obtain, it is advisable to build up an insurance fund by charging costs and crediting the reserve fund monthly with the approximate legal reserve cost of the insurance if purchased outside. This will in time provide a fund of sufficient size to take care of any fire losses. However, the risk of loss in the early years before the fund has assumed sufficient proportions presents an argument against the initial establishment of such a fund unless adequate insurance can be carried during the accumulation of this reserve and then reduced as the reserve increases.

Depreciation and Obsolescence

The depreciation of machinery in the chemical industry depends on so many factors that the rate, which will vary from 10 per cent. to 20 per cent., or more, can best be determined by a careful study of the conditions existing.

Obsolescence is a material factor in the chemical industry, due to the frequent changes in manufacturing equipment and, in the case of minor chemicals, the discovery of other chemicals to replace the use of those now being produced. To determine this factor of obsolescence is most difficult, yet it is an element of cost which can not be overlooked. The amount is determined by studying the facts in each case, and by the judgment of the chemical engineers acquainted with the particular problem. To enable the proper distribution of this element of cost as well as those other elements of cost which are based on plant values, it is essential to maintain careful and detailed departmental records of the investment in the plant.

Works Expense

The works expense in a chemical plant includes such items as superintendence, indirect labor, laboratory expense, general works expense, works office expense, watchmen, insurance, first aid expense, plumber shop expense and the costs of other service departments. The number of classifications kept depends on the detailed data desired.

Many of these items are easily distributed on separate and equitable bases. For example, first aid expense which would represent the cost of conducting a works hospital can best be distributed to the various departments on the basis of the number of treatments received by the employees of those departments during the month.

Some of the service departments such as carpenters' shop, plumbers' shop and machine shop present individual cost problems in production order cost accounting. Service departments are primarily concerned in repairs, renewals, and additions to the plant. Rather than charge repairs with the overhead of these service departments or capitalize the overhead, it is more conservative to charge this overhead into manufacturing expenses. This method also avoids the pyramiding of overhead on account of interdepartmental charges and credits.

For those items of overhead which can not be distributed on a special basis, an equitable plan of distribution must be adopted.

After giving due consideration to all factors involved the "man rate" seems to be the most satisfactory, whereby each process is charged a portion of overhead based

on the number of dollars expended for labor in that process, in its relation to the total productive labor cost. The labor employed in a chemical plant ranges from ordinary manual labor required in handling materials and furnaces, to the skilled labor required to watch the chemical processes. This condition makes the use of the man hour method unsatisfactory.

Emasculation of Organic Chemical Industry

Criticism of Prohibition Enforcement Methods Before the American Institute of Chemical Engineers

By DR. MILTON C. WHITAKER
Vice-President, U. S. Industrial Alcohol Co.

If, within the next five years, the United States were thrown into war with a power such as Germany, whose chemical resources have been highly developed, and which could, within an hour's notice, begin turning out poison gases and high explosives, our defeat would be assured. We could not hope to compete with such a power in the production and use of such death-dealing agencies, which factors will decide the wars of the future.

Prohibition has stifled the country's chemical industries; it has killed off its potential powers of defense and offense; it has ruthlessly cut down the bulwarks which American chemists might rear for the perpetual protection of the native land at but a trifling cost. To manufacture one pound of smokeless powder, one-half pound of ethyl alcohol (grain alcohol) is necessary. To make one pound of poison gas the same amount of alcohol must be used. At the outbreak of the last war I made a survey for the government on the amount of alcohol the country was producing, and through the fullest use of its manufactories, might produce. At that time I found our capacity to be 650,000 gallons a day, and so reported to the government. Not a cent was spent to erect new plants to care for this essential industry. It was already here and willing to turn its resources over to the government.

But since prohibition and its reign of senseless, fanatical, destructive enforcement, this industry has been more than half destroyed, and time is only needed to complete the destruction. Today the United States is capable of producing just 47 per cent. of the amount of alcohol it could have produced before prohibition. Mind you, I do not say it is producing that amount; I say that, with every one of its manufactories running full time, that is all it could produce. The other plants have been killed off and dismantled by prohibition.

The present methods of enforcing prohibition are most destructive and oppressive. Those in power do everything possible to discourage the manufacture of alcohol for legitimate purposes, not heeding our warning that they are tearing down America's one sure weapon of defense, even though we have complete disarmament. If we were thrown into a war tomorrow we would not have alcohol enough to run it. Remember what happened in 1914. Germany had developed her industrial chemical works. It had fostered them, subsidized them, trained chemists and encouraged them to work, for what? That when "the day" came these giant peace-time industries heard the call and, by changing their methods of operation in only one or two particulars, were turning out lethal weapons against which the guns and cannons of England and France were children's toys. It nearly won for them; it would without doubt have won for them had Britain and France deliberately killed off their means of retaliation as we are now killing ours.

Accident Hazards in the Operation of Filter Presses and Centrifugal Dryers

By M. F. Crass

The Grasselli Chemical Co.

THE old-time filter press, as a usual thing, was equipped with a capstan, screw, and bar for tightening and loosening plates. Operating this press was a very arduous job, especially in the final winding up of the press and tightening the plates, and it frequently became necessary for the operators to apply extension bars on the capstan bar in order to get sufficient leverage or pressure to tighten the press up to the desired point*.

Accidents have been caused by this auxiliary bar slipping. There also have been instances of men standing on the bars in order to get added pressure or weight to bear on same, which practice has resulted in falls with more or less serious injury to the workmen. Severe strains also have resulted from the excessive effort required, with its promotion of hernia and other like strain-results. In order to avoid the evils attendant upon the operation of this old-style press, other types of presses have been designed.

Hand Operated Presses

Hand operated presses may be of the direct drive or gear-drive types. Either type may be operated in three different ways, viz., (a) by removable bar and capstan, (b) by fixed bar in ratchet, or (c) by a hand wheel.

Removable bar and capstan is the oldest type. It has the advantage of low first cost and is satisfactory for low pressure filters. It also has the least number of wearing parts. Its disadvantage is that its operation places heavy strain on operators except for the lowest pressures.

Fixed bar in ratchet operation is an improvement and can be installed on the old type presses. The advantage is that it keeps the bar in the most advantageous position for operation at all times. The chief disadvantage is that the ratchet occasionally fails to catch when the cogs are worn and allows the men to slip or fall. This, however, can be avoided by careful inspection.

Hand wheel apparatus is easier and safer to operate than the capstan bar, is probably faster in operation, and can be operated without a man throwing himself off his balance. It, however, does not provide the leverage necessary for tightening up presses of the larger type.

A gear drive requires less effort for obtaining the necessary pressure on plates and so decreases the strain on the men and also lessens the chances of slipping and falling. It, however, is slow in operation and costs nearly as much to install as the hydraulic press.

A study of the various methods employed in operating the hand-operated press leads one to the conclusion that a gear drive operated by as large a hand wheel as the distance between the shafting and the floor will permit, seems to be the best arrangement, as the gears can be made with such a ratio that they will more than compensate for the decrease in the leverage of the wheel over the bar. This type can be used where it is impossible to install or operate a hydraulic press. In no case excepting for the very lightest press, should a filter press be operated with a bar.

Hydraulic Presses

Wherever it is possible to install this type of press, it has undoubted advantages; it is faster in operation, and accidents are eliminated in connection with its operation. There are few detracting features and those who have used it have obtained satisfactory results in labor saving, general efficiency of operation, and maximum capacity. Where a high-powered or large size press is required the hydraulic press is the most satisfactory in the long run. Its only disadvantage lies in its first cost.

Centrifugal Dryers or Extractors

Under no circumstances should a centrifugal dryer be operated without a suitable casing. Should the extractor ever give way, the casing should be strong enough to retain the broken pieces of metal which otherwise would fly out at terrific speed endangering the lives of nearby workmen. In some cases cast iron casings have been supplied. Cast iron shatters rather readily, especially under severe blows, and for this reason its use is not recommended.

Casings made of steel have a much higher tensile strength and will afford almost absolute security in case the basket breaks. It is estimated that the casing should be of 5/8-inch steel when the capacity of the basket is 100-200 pounds. The casing should have suitable openings so the basket can be inspected without being removed. If these casings are properly constructed an operator will be practically immune from danger providing the extractors are properly operated. No operator should be allowed to lean over baskets or attempt to level off the load in the basket after the power is thrown on and the basket put in motion.

A band brake and spring designed to apply the proper safe friction in stopping the basket should be installed on each centrifugal. These band brakes are adjustable but are equipped with locks so that operators cannot tamper with them and vary the amount of friction which can be applied. The adjustment of the brakes should be carefully supervised by responsible men.

It is our belief that these brake regulating devices and the safeguards thrown around their use are the secrets of exemption from accidents in connection with the operation of this apparatus. Further security can be had by following the practice of making daily inspections of each centrifugal. This should be done by some competent person in the department where the machines are used. These daily inspections should be checked up by monthly inspections by a competent engineer, at which time the inspection bars in the casings should be removed for the thorough inspection of the baskets.

John D. Rockefeller has provided funds for the purchase of the birthplace of Pasteur at Dôle in the Jura. It will be transformed into a depository of the authentic documents of Pasteur.

* * *

Newton Lamb, formerly chemist at the Marcus Hook, Pa., plant of the National Aniline & Chemical Co., is now instructor in chemistry, Central High School, Philadelphia.

* Presented at Boston meeting, National Safety Council, Chemical Section, Sept. 27-28, 1921.

CHEMICAL AGE

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A Consolidation of
The Chemical Engineer
and Chemical Age



A LONGSIDE of Irving Fisher's gutta-percha dollar is Henry Ford's unit of energy as a basis of national currency, submitted for the consideration of the American people in connection with his proposal of the Government's completion of the Muscle Shoals' power development and its sale and lease to him as part of a plan that Mr. Ford claims will work an industrial transformation of the South.

Mr. Ford's genius in multiple production assures an audience for observations in more or less related fields, whose soundness harmonizes with his characterization of history, which is recorded experience, as "bunk." Not only is current news from continental Europe replete with the distress resulting from such procedure as he proposes the Government should use to finance the completion of the Tennessee river dams, but our present economic disorder largely is its reflection.

Aside from Mr. Ford's delusion, whether the Government will accept the conditions of his offer and provide the opportunity that he asks, the present Congress will decide, influenced strongly by the official opinion of Secretary of War Weeks. Mr. Ford already is identified with chemical industry in plants that supply many of his raw materials. His broader introduction into established chemical fields, with the advantage of cheap hydro-electric power, makes the subject of the Government's disposition of this war-time investment and the expenditure of additional capital for completion, of peculiar interest to industry generally.

THE observations of President Dunham of the Hercules Powder Co. in this issue of CHEMICAL AGE merit the study of every plant and sales executive. Can we not interpret the rising tide of such combination as is practicable under the statute as indicating that production costs with present facilities and volume of business are at their minimum as regards a given plant and that further reduction

can be the result only of integration horizontally or vertically?

Horizontal integration means the combination of production activities of units producing the same goods, whereby advantage is gained in purchase of raw materials and in distribution of the finished products. Vertical integration means an independent self-sufficiency from raw materials to the finished products. We have in Germany today a nation organized to the limit in these two directions.

It is in this tendency, enforced by depression and loss and confronted by foreign production costs that spell destruction and not competition, that the fullest measure of waste elimination may be attained in American industry. Increasing abundance of goods at a price the people can pay is what the world needs. President Dunham as a chemical administrator in a highly integrated field epitomizes present industrial philosophy when he says that production men must think more of reduced costs than of increased production, for production can increase only as costs are reduced.

SENATOR KING'S (Utah) amended resolution to investigate the activities of synthetic organic chemical manufacturers to conserve the American industry by appropriate legislation, and of the opposing activities of German agents and of certain American importers, should be regarded by the chemical industry as a great educational opportunity.

In the futile search for what does not exist will be disclosed a commercial organization which stands as a sentinel at the outpost of economic preparedness for national responsibilities in both peace and war.

The response of the people to the program of men who would sacrifice national security and industrial independence to promote the welfare of the German chemical monopoly, should make imperative the legislation needed to protect American enterprise in synthetic organic chemistry, and which Senator King's resolution originally was designed to circumvent.

Shall German monopoly, as unscrupulous as its scientists are capable, deprive America of its opportunity to become self-sustaining in the uniquely fundamental industries of peace?

Shall the present indifference of Americans be the basis of future helplessness in an industry without which a defensive war can not be waged?

Shall a group of men, agents of a caste that would enslave the world and which came near it, bedevil American industry and becloud an issue of national existence?

These are questions that CHEMICAL AGE has urged should be put directly to the American people.

Senator King's investigation of the alleged monopoly in the business of organic chemistry, which Senator Frelinghuysen (New Jersey) made to embrace the pernicious activities of German agents, should enforce an answer.

NEVER has greater responsibility been placed upon a special class than that borne by American technical men. It is their function so to conduct the processes of production and to guide American labor that the least measure of dependence needs be placed upon the politician to provide that artificial restriction to the free exchange of goods designed to equalize production costs.

Never has greater need for the free exchange of goods so pressed down upon a distraught world, for only thereby can debts be paid, the burden of taxation lessened and capital accumulate to flow where gain is greatest.

Our prime consideration is the fullest measure of employment of our citizens and the development of industries essential to national independence. The former is a function of production costs; the latter of temporary legislation, an example of which made possible the establishment, among many others, of our alkali industry.

Exhaustion of foreign purchasing capacity, started the slump out of which we now slowly are making our way, the rate of progress being determined by the cooperation of labor, the influence of whose efficiency in determining our national responsibilities in the rehabilitation of the world never has received the emphasis which its importance deserves.

With our unmatched resources and facilities for production, is it not a commentary on the leadership of American labor that its conduct in industry and in politics has been to sacrifice national efficiency in world competition? The appeal to the politician for that artificial aid, which in its affront to natural law under present conditions not only is of doubtful help to us but a deterrent to recuperation everywhere, discloses the results of this abuse of power.

Inasmuch as our first responsibilities certainly are to ourselves, their performance and thereby the capacity acquired to help others, demand a measure of teamwork on the part of every element of industry that an ever greater abundance of cheaper goods may flow in unrestricted channels in the trade of the world. This is the imperious demand of the new economic order, denial of which only makes slow, if not impossible, of accomplishment the things that should be done to set the world aright.

WE have given prominence to the growth of the Stamford Chemical Society as an independent and self-governing economic organization of chemists, because its enterprise serves as an example to American chemists that the progressive solution of their material problems and the development of their potentialities as industrialists and citizens depend upon similar enterprise.

Such organization is accountable only to its members and to the industry of the community and is designed to be of the maximum material aid to each

of these factors in individual growth. This provides a basis of service of such strength that the coalescence of similar organizations into a state economic society of chemists, devoted to the promotion of the state's chemical industries and the welfare of its personnel, would be an early, logical eventuality.

Such economic organization does not conflict with our scientific society, but complements it in the vast field of chemical industry. The obsession of monopoly of service in this field not only is at the sacrifice of the intimate interests of its personnel, but is a constant beckon to the abuse of power.

In this connection we wish to note the action of the board of governors of the New Jersey Chemical Society in voting overwhelmingly against its absorption by the American Chemical Society, and the proposal initiated by the latter organization that the Stamford Chemical Society sink innocuously into a section under an agreement that in consideration of a dollar and a half per member per year and inclusion in the mailing list for New York local meeting announcements, it shall not ally itself with any organization independent of the American Chemical Society.

Such segregation as we have outlined and as has been initiated in numerous places, promises the fullest measure of satisfaction of the needs of American chemical industrialists for independent and distinctive economic organization. Seeking to nullify an ambition which should be encouraged opens further the door to the realization of this ambition.

THE Christmas season is appropriate for the acknowledgment of our appreciation of the confidence and esteem accorded *CHEMICAL AGE* in a period of bad business, shut-down plants and unemployment.

Men in industry subscribe for and read a technical paper for the stimulation incident to the perusal of its contents. The growth of *CHEMICAL AGE* is proof that there is in American chemical industry, in administrative positions in every department of manufacture and trade, a great body of men untouched by existing instruments of education and especially responsive to a publication like *CHEMICAL AGE*.

We realize our short-comings just as keenly as we appreciate the possibilities of *CHEMICAL AGE* as an independent monthly journal of chemical enterprise in America.

With the confidence of our convictions and courage in their expression, with the sole motive of constructive service in the fundamental field, we greet our friends with gratitude and good wishes, in allegiance to the principle that industry is great only as its personnel is great, and that the most important thing in industry is its human raw material.



Steele Chemistry Building, Dartmouth College, Hanover, N. H.

Chemical Instruction at Dartmouth College

A Description of the Dedication and Equipment of the New Steele Chemistry Building

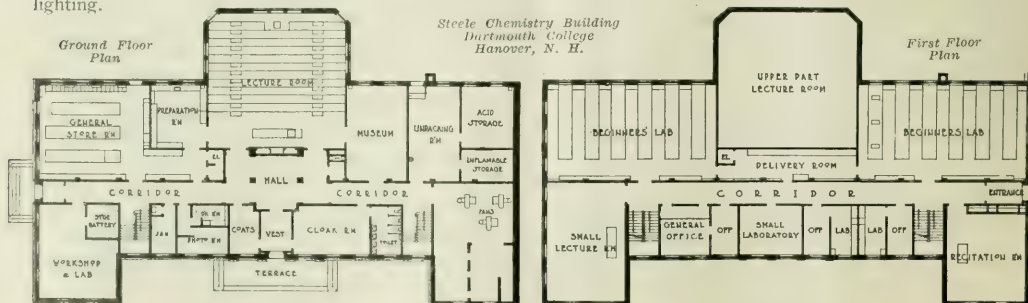
THE latest addition to the equipment of Dartmouth College is the Steele Chemistry Building, which was opened at the beginning of the present college year. The building and equipment involve an outlay of about \$500,000, which was in part covered by a bequest of \$250,000 from Sanford H. Steele, of the class of 1879, former president of the General Chemical Company and trustee of the college. This bequest was in memory of his brother, Benjamin H. Steele, of the class of 1857.

The structure is Georgian in type, designed by the architects, Larsen & Wells of Hanover, N. H., to harmonize as well as possible with the older buildings of the college. The central portion is four stories in height, with wings of three stories. The latter are capable of supporting another story if need arises. The material is red brick, with trimmings of Indiana limestone. The interior is of steel frame construction, supporting hollow tile partition walls, with concrete floors overlaid with hard wood.

As shown by the accompanying plans each floor is divided longitudinally by a corridor into two portions of unequal width. In the wider part, to the north, are located the larger laboratory rooms, with the store rooms which serve them; while the narrower portion is occupied by the smaller laboratories, offices, private laboratories, and other rooms of this type. Particular attention has been paid to thorough and adequate lighting.

As there is no basement the first floor serves, in part, for machine and storage rooms, giving the unusual advantage of well lighted spaces for these purposes. In addition a lecture room, seating 250, with adjoining lecture preparation room, and museum, are found here. On the second floor are two laboratories for beginners, a smaller lecture room, and a recitation room. The third floor contains the laboratories for qualitative and quantitative analysis, for physical chemistry, and a large library. On the fourth floor are the organic and the physiological chemistry laboratories. In various parts of the building there are, in addition, smaller laboratories for advanced inorganic chemistry, for advanced organic chemistry, a combustion room, balance rooms, a senior room, storage battery room, dark room, shop, coat rooms, a large general office, and six laboratory-office suites for instructors.

The equipment is reasonably complete both for purposes of instruction and for research. The laboratory furniture was worked out and constructed by the L. E. Knott Apparatus Company of Cambridge, Mass., in accordance with rough designs furnished by members of the department. The material is oak, with table tops of soapstone. The problem of ventilation is cared for in some laboratories by table hoods; in others by wall hoods of special design working on the baffle plate principle. Ten fans are required to furnish suction from these hoods; the flues being made of Robertson



metal. A separate system working through two large fans supplies warm air to each of the large laboratory rooms to replace that drawn out through the hoods. The building is piped for gas, hot and cold water, distilled water, compressed air, and steam under twenty pounds pressure. An automatic electric elevator and an intercommunicating telephone system are provided. Outlets are placed in each room for two electrical circuits; 220-volt direct and storage battery system. The building is lighted by electricity, using large semi-indirect fixtures, and is heated by steam.

The formal opening of the structure took place on October 29th in accordance with the following program:

Transfer of the Building to the Department of Chemistry, by Dr. Ernest M. Hopkins, Dartmouth College; Response, by Prof. Leon B. Richardson, Chairman of the Department of Chemistry, Dartmouth College; Sanford H. Steele, by Dr. William H. Nichols, President, Allied Chemical & Dye Corp.; Fifty Years of Chemistry; Our Heritage and Our Obligations, by Dr. Henry P. Talbot, head of the Department of Chemistry and Dean of the Massachusetts Institute of Technology.

The number of students enrolled in the courses of the department is about 650. The instructing staff numbers seven, with five assistants. The main function of the department in a college of the nature of

Dartmouth is to furnish instruction in chemistry as a part of the general training of the undergraduate. Opportunities are offered, however, and are accepted by a constantly increasing number of men for specialization in chemistry.

The general scheme of the curriculum, with numerous required courses in the political and social sciences and in the languages, prevents this specialization from becoming a narrowing process. The department endeavors to equip such men with a thorough knowledge of the fundamentals of inorganic, analytical, organic and physical chemistry. They are then advised to build upon this foundation by further work in the graduate schools of other institutions and in the technical schools. Most of them do this, although some have entered chemical industry at once, with better success than might have been anticipated.

In the future, with the new equipment, the same process will be continued except for the possibility of providing more definitely for one year of graduate work, with the Master's degree as the result. Neither the department nor the college as a whole has any intention of adding itself to the number of institutions which maintain graduate schools of the more advanced type. The improved facilities for work therefore will be devoted almost exclusively to the development and improvement of the chemical instruction of the college undergraduate.

Synthetic Organic Chemical Manufacturers' Association

FINAL steps in the organization of the Synthetic Organic Chemical Manufacturers' Association were taken at a meeting held at the Pennsylvania Hotel on December 16. Three additional members were elected to the Board of Governors, viz., Frank L. McCartney, Monsanto Chemical Works, St. Louis, Mo.; James T. Pardee, Dow Chemical Company, Midland, Mich., as representatives from the Fine Organic Chemical Section; and Donald McKesson, McKesson and Robbins, New York, from the Pharmaceutical Section.

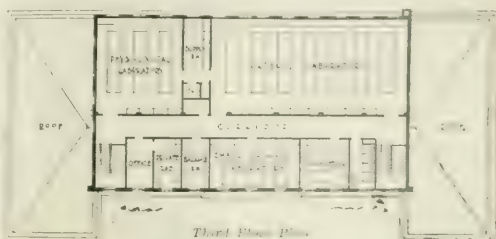
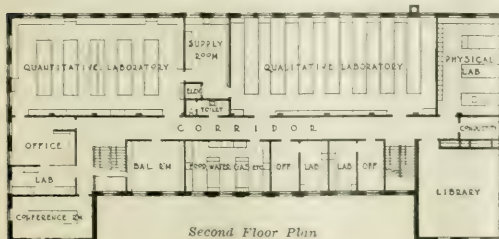
The association directed the appointment of a committee to co-operate with the Chief of the Division of Hygiene and Engineering of the Department of Labor and Industry of Pennsylvania on a National Code of Safety Standards.

A resolution was unanimously adopted expressing the appreciation of the industry of the service which had been rendered the industry by the Tariff Commission through its annual census on dyes, and expressing the hope that the Commission would be able to extend this service to include all the branches of synthetic organic chemical manufacture represented in this association.

President Chas. H. Herty announced that he had sent a telegram to President Harding urging the speedy enactment of a tariff law which would include the feature of American valuation of imports, and that a copy of

the resolution setting forth the unanimous views of the members of the association on the question of American valuation had been forwarded to Chairman Penrose of the Senate Finance Committee. The following 65 concerns comprise the present membership:

Abbott Laboratories, The, Chicago.
Agawam Chemical Works, Inc., Providence, R. I.
American Aniline Prod., Inc., New York.
American Chemical Products Co., Rochester, N. Y.
Bayer & Co., Inc., New York.
Beaver Chemical Co., Inc., Damascus, Pa.
Beaver Manufacturing Co., Ballardvale, Mass.
Butterworth-Judson Corp., New York.
Calco Chemical Co., The, Bound Brook, N. J.
Campbell & Co., John, New York.
Carbide & Carbon Chemicals Corp., New York.
Chatfield Manufacturing Co., The, Cincinnati, O.
Chemical Co. of America, Springfield, N. J.
Chiris Co., Antoine, New York.
Citro Chemical Co., Maywood, N. J.
Cleveland-Cliffs Iron Co., New York.
Coleman & Bell Co., The, Norwood, O.
Condensite Co. of America, Bloomfield, N. J.
Dermatological Research Institute, Philadelphia, Pa.
Dow Chemical Co., The, Midland, Mich.
Du Pont de Nemours & Co., Inc., E. I., Wilmington, Del.
Dyanilin Chemical Co., Inc., New Brunswick, N. J.
Dye Products & Chemical Co., Inc., New York.
Eastman Kodak Co., Rochester, N. Y.
Essex Aniline Works, Inc., Boston.
Fries Brothers, New York.



Gary Chemical Co., Gary, Ind.
 Gaskill Chemical Corp., Brooklyn, N. Y.
 General Bakelite Co., New York.
 Granton Chemical Co., New York.
 Grasselli Chemical Co., Cleveland, O.
 Heller & Merz, The, Newark, N. J.
 Heyden Chemical Co. of America, The, New York.
 Interstate Products Corp., Bristol, Tenn.
 McKesson & Robbins, New York.
 Mallinckrodt Chemical Co., St. Louis, Mo.
 May Chemical Works, Newark, N. J.
 Maywood Chemical Works, Maywood, N. J.
 Merrimac Chemical Co., Boston.
 Monsanto Chemical Works, St. Louis, Mo.
 Newport Chemical Works, Inc., Passaic, N. J.
 New York Quinine & Chem. Works, Inc., New York.
 Nitro Powder Co., New York.
 Noli Chemical & Color Works, Inc., New York.
 Peerless Color Co., Bound Brook, N. J.
 Pharma Chemical Corp., New York.

Radiant Dye & Color Works, Brooklyn, N. Y.
 Redmanol Chemical Products, Chicago.
 Republic Creosoting Co., Indianapolis, Ind.
 Rhodia Chemical Co., New York.
 Roessler & Hasslacher Chemical Co., The, New York.
 Seydel Manufacturing Co., Jersey City, N. J.
 Standard Chemical Co., Bayonne, N. J.
 Stanley Chemical Co., The, East Berlin, Conn.
 Synfleur Scientific Laboratories, Monticello, N. Y.
 Synthetical Laboratories of Chicago, The, Chicago.
 T. M. & G. Chemical Co., Belleville, N. J.
 Thatcher Process Co., Inc., Syracuse, N. Y.
 Tower Manufacturing Co., Inc., New York.
 Trico Chemical Co., Inc., Buffalo, N. Y.
 Uniform Color & Chemical Corp., Perth Amboy, N. J.
 U. S. Industrial Chemical Co., New York.
 Walker Chemical Co., The, Pittsburgh, Pa.
 Wilbur White Chemical Co., The, Oswego, N. Y.
 Zinsser & Co., Hastings-on-Hudson, N. Y.

Improved Method of Treating Rosin in Varnish Making

THE issuance of U. S. Letters Patent 1,395,874, to Dr. F. P. Veitch, chemist in charge; Wilbur F. Sterling, assistant chemist, and Victor E. Grottsch, of the Leather and Paper Laboratory, Bureau of Chemistry, U. S. Department of Agriculture, illustrates not only research enterprise in the Department of Agriculture, but an example of a patent issued to government scientists and dedicated by them without qualifications to the people.

It will be recalled that a year ago was rife the project to establish by legislation a system whereby the patents of government employees would be transferred to the Federal Trade Commission and by it licensed to private manufacturers, the royalties to be accumulated in a fund for distribution to the inventors and otherwise.

The patentees state in their specification for a new method for making varnish materials that this application is made under act of March 3, 1883, chapter 143 (22 Stat., 625), and the invention described and claimed may be used by the Government of the United States, its officers and employees and by any person in the United States without payment to us of any royalty.

This invention relates to the use of certain catalysts in methods of making varnish resin materials and the like, including resin esters, whereby esters, anhydrides, lactones and the like, in some cases of almost complete neutrality, can be prepared, and the present well-known process thereby simplified.

When grinding, or mixing a pigmented varnish in which resins, containing a large amount of acid material, form one of the constituents, the acid resins combine with the basic pigments such as the metallic oxides, and cause "livering" or thickening of the product, thereby rendering it unfit for use.

This difficulty can be overcome partially by neutralizing the acid resins with lime. However, if they are neutralized to a sufficient degree to avoid "livering," the neutralized products are insoluble in the varnish maker's solvents. By esterifying the acid resins with glycerin or other organic hydroxy bodies, esters of various degrees of neutrality can be formed, which do not "liver" with basic pigments. The usual practice is to heat together at a suitable temperature resin and glycerin under various conditions of pressure, in vacuo or in an atmosphere of an inert gas. Considerable trouble and time are required in this way to produce esters of sufficient neutrality.

By this invention it is possible to shorten the time required for union of the resin and hydroxy body con-

siderably, and to produce at will resin esters with an acid number of less than 2, or of any other number.

When rosin is heated in the neighborhood of 300° C., considerable anhydride material is formed. This anhydride is not quantitatively determined by aqueous potash, so it is necessary to titrate with alcoholic potash in determining acid numbers. This gives the total acidity. Besides rosin, other acid resins may be esterified, such as various copals, shellac, dammar, etc.

Rosin will be used to illustrate the advantages of the present invention. 150 parts rosin, 20 parts glycerin, and 0.5 finely divided zinc were heated in an acid resistant container fitted with an air reflux condenser, between 275° C.—280° C. for ½ hour. The condenser was then removed and the temperature raised to 310° C. to drive off any excess glycerin. By this process a product having an acid number of 0.9 was obtained. Several duplicate experiments gave acid numbers in each case less than 1.5. Equivalent amounts of zinc oxid, and zinc carbonate gave similar results.

450 parts rosin and 60 parts glycerin were heated in a zinc-lined container, fitted with an air reflux condenser, between 275°—280° C for ½ hour. The condenser was then removed and the temperature raised to 310° C. and the mass allowed to cool to 160° C. out of contact with the air. The acid number was 1.2.

When the experiment was carried out under similar conditions, but not in the presence of zinc or zinc compounds, it was necessary to heat the mixture for 2 hours to obtain a product of similar acid number. It is evident that zinc and zinc compounds greatly accelerate the reaction and enable it to go to completion in much less time than otherwise.

When the process is carried out in the presence of finely divided zinc, or in a zinc lined container, the zinc is affected to only a very slight degree by the molten resin, as shown by the fact that only about 0.2% of zinc is taken up by the esterified resin. When zinc oxid or carbonate is used in place of zinc, these are entirely absorbed by the resin. This may be advantageous by increasing slightly the hardness of the final product.

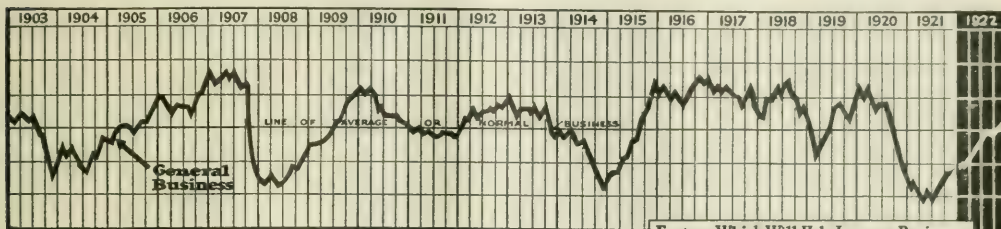
Rosin and many other resins, when heated over 200° C., in contact with the air darken rapidly. This is caused almost entirely by oxidation. The longer molten resin is exposed to the atmosphere the darker it becomes. During the reaction between resins and glycerin, water vapor and other vapors are given off and retained in the reaction chamber by means of a reflux condenser. These vapors displace the air and keep the oxygen of the air away from the product, thus retarding the darkening. In every case where zinc compounds

were used the product was much lighter in color than resins formed under similar conditions without the use of zinc or zinc compounds. This is probably due to the fact that by the use of zinc, etc., the reaction is more rapid and consequently there are more vapors given off per unit time in the chamber than otherwise, and the mass is in a molten condition, only about $\frac{1}{4}$ of the usual time. Therefore, resin esters produced by the aid of zinc or zinc compounds are superior in color to those produced without the use of these catalytic bodies.

The presence of zinc or zinc compounds was found to be beneficial when the process of esterification of resin and glycerin was conducted in vacuo or in an atmosphere of an inert gas. In both cases the reaction was greatly accelerated and the resulting product was practically neutral.

By proper regulation of the time of heating, or the temperature if desirable, or both, resin esters of any desired degree of neutrality or acidity can be produced. The resin esters produced in the manner described above, may be incorporated with the usual varnish oils such as linseed oil, China wood oil, etc. Driers may be added, and the mass thinned to the proper consistency with turpentine or any other varnish thinner. They may be used with basic pigments without danger of "livering," or in cases where acidity is not a factor, may be mixed with acid resins.

If, as is sometimes desirable or advantageous, it is necessary to esterify a mixture of acid resins with glycerin or other similar hydroxy body, the same may be accomplished more readily and easily by the use of zinc or zinc compounds as catalysts.



Better Business in 1922

ACTIVITY in sulphuric manufacture is determined by the prosperity of farmers in regions where crop growth is dependent upon the use of acid phosphate. The manufacture of tanners' chemicals reflects directly the inflated wage-cost ingredient of boots and shoes. The great industries based upon the elaboration of the products of coal tar are dependent absolutely upon legislation that will protect them from the destructive competition of German products. The staple chemicals essential to the construction industries stagnate in production because union labor in its inordinate wage-demands restricts a form of enterprise that registers social progress. Activity in the various branches of chemical manufacture, some outstanding examples of which we have cited, depends upon initial activity in industries whose essential raw materials they supply, and which are more directly in contact with the consumer for whose increase of purchasing capacity the world awaits the slow but sure procedure of economic law.

As goods undergo the slow process of price deflation, unchanged transport costs increase as a percentage factor to restrict distribution and further to aggravate the maladjustment by neutralizing the gain thus made. Out of the contradictions and inequalities that have marked the depression of the past eighteen months, order and stability are shaping themselves. The wage that will conduce to full employment is being enforced slowly but surely by a demand whose weakness denies that the present prices of goods in many lines are right. In many industries, chiefly the agricultural and extractive, adjustment has been affected. In the manipulative industries, chiefly those dominated by unionized labor, the movement of goods awaits a wage that will make possible a price the people will pay. Concessions come slowly from class selfishness and only under the lash of distress.

As the channels of distribution narrow, greater becomes the labor (service) cost ingredient of the price

Factors Which Will Help Improve Business

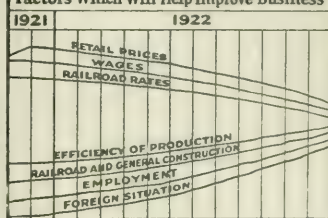


Chart of Business Conditions (1903-1921), prepared from figures compiled by American Statistical Association

of goods and so we find in retailing little or no reflection of the deflation so conspicuous at their source, which results in a denial to half of our people of the power to buy on a fair level of exchange. Only as this maladjustment is corrected by the reduced cost of transport and of manufactured goods will the line of general business ascend in 1922 as is foretold in the accompanying chart of business conditions.

This chart, submitted by the Laclede-Christy Co., St. Louis, Mo., is based on figures compiled by the American Statistical Association. The horizontal line represents the average or normal business, for the 17-year period. The serrated line represents general business' activity, including all lines, both production and distribution, but not prices.

Signs of improvement in business conditions are becoming more numerous as the spirit of co-operation finds expression in a willingness to accept a wage of lower rate but of higher purchasing power. Whether the prophecy of better business in 1922 will be realized in the measure that many anticipate depends upon the factors indicated in the small attached chart shown above. Retail prices and wages are inseparable in any movement, for the latter constitutes the greater part of the former; that they must come down is inevitable if business recovery is to proceed; the same applies to transportation costs for they directly determine accessibility with all that it means in the movement of goods.

President Dunham, Hercules Powder Co., directs

attention to the fact that increased efficiency of production means lower production costs which are a function of the volume of business transacted and so inseparable from volume of production. Reduction of production costs is not practicable with low consumption which is low purchasing capacity.

Improvement in general construction is notable in the larger centers, but the under-built condition of the country can be corrected only as the three factors noted above descend in the graph. Railroads in their maintenance, repairs and improvements constitute the largest single buying unit in the country, but they can exert their influence in general business recovery only as their management may be permitted to conduct their business after the manner of private enterprise. Increase of employment will come just as rapidly as individual initiative in industry is permitted free play to respond on the one hand to its own needs and on the other to the law that labor is paid out of what it produces and the more it produces the more it gets.

The foreign situation in its influence on domestic business recovery is a controlling factor, for not only are our raw material prices determined by the sales value of the surpluses in the markets of the world, but the ability of nations to consume them depends upon a market for the finished products they make out of them. With political and economic instability, reflected directly in a disparity of exchange that makes Central Europe the cheapest market for manufactured products and America the most favorable market in which to sell, the salvation of American industry in many lines is involved in a competition that only can spell destruction. The purchasing power of our people can not be increased by any process that puts American enterprise out of business. Purchasing capacity flows from employment.

Here is the grand contradiction, to reconcile which we can only leave to time and the never-failing resourcefulness of the race.

We do not begrudge the debt of war, but we revile the methods of taxation designed to pay it. Methods of taxation in force not only hamper industry and restrict employment by depriving it of the fructifying influence of new capital deflected into tax-exempt securities, but are incident in a manner to constitute the chief mainstay of high prices.

A consideration of the factors which will help to improve business in 1922 indicates the necessity of co-operation, of compromise and concession, of every element that enters into the cost of goods.

Stamford Chemical Society

Carl P. Stevenson, M.S., and former instructor, Massachusetts Institute of Technology, now chemist with Arthur D. Little, Inc., addressed the Stamford Chemical Society on November 28 on "The Objectives of Research," which he outlined under the three general captions of price, quality and service.

Price is the summation of materials and labor costs and can move the product only as the chief cost ingredients make it possible for the people to buy. The chemist's contribution to the creation of the right price lies in the inspection, analysis and selection of materials most suitable to efficient plant operation and covers the study of every inanimate raw material as well as the goods in process of manufacture. It embraces as well the study of labor costs involved in the operation of chemical machinery, for these express the efficiency of a variable tool applied to the transformation of matter and falls within the purview of plant-control work

In quality of the product is merged all the influences affecting the raw materials throughout the process changes and it can be maintained on a high and uniform level only by unceasing scrutiny of the course of manufacture, expressed in standardization of intermediate and final products.

Service is that responsibility of the chemist to keep the product sold and to find new uses and to enlarge the consumption in a present market by faithful cultivation of the buyers ability to use it to the best advantage, in which the chemist cooperates with the salesman.

Alert manufacturers leave no stone unturned to cultivate and utilize the commercial instinct of their chemists, but many more neglect to take them into their confidence in the solution of distribution problems, with the result that team work falls short of its possibilities because of such neglect. The place of the chemist in manufacture must be made by himself. Too often he himself is responsible for the attitude of executives who look upon him as the denizen of a more or less mysterious retreat from which is produced information used by men of administrative ability in the business of chemistry. Chemists as a class too readily are satisfied to have themselves accepted merely as tools of more resourceful men. Out of the 10,000 chemists today unemployed or engaged in non-chemical pursuits the plight of a large proportion can be laid to a lack of plain business gumption.

Mr. Stevenson continued his discussion of the chemist's reaction to the responsibilities of production to relate the present experience of his organization in the average receipt weekly of 10 applications for employment which requires the devotion of each Monday forenoon to answering. Following Mr. Stevenson's address was the presentation of the U. S. Bureau of Mine film, "The Story of Sulphur."

The Stamford Chemical Society does not commit itself to the promotion of independent economic chemical organization in Connecticut, believing that its influence in this direction can be exerted most effectively by the performance of needed functions in its own community. Thereby will be established a precedent for broad-minded chemists in other communities of the state, more populous chemically, to organize along similar lines and, if possible, to surpass them in service to their respective memberships.

Economic organization of chemists along state lines must be created by the men themselves first in their own communities with later coalescence into a state body, thereby providing the stability inherent in a thing that grows and serves because it is needed. The Stamford Chemical Society has provided that precedent for the chemists of Connecticut and so has made itself a worthy subject of comment. The society's present local activities are embraced in the work of three committees, viz.,

Committee on Publicity—To have charge of acquainting the general public with the nature of the work of the chemist and his value as a member of the community.

Committee on Chemical Education—To advise those who contemplate entering the chemical profession regarding education, opportunities, etc.

Committee on Information as to Chemical Resources—To collect and tabulate information regarding the chemical resources of the community as to both materials and personnel, and to make such information available to chemists and others.

On Dec. 19, members and invited guests will be entertained at a smoker at the Suburban Club. On Jan. 3, F. Kraissal, New York Manager, Corning Glass Works, will address a public meeting on the manufacture of chemical and domestic glassware, illustrated by motion pictures.

Material Handling in the Elimination of Industrial Waste

By Harold V. Coes,

Manager, Ford, Bacon & Davis

MODERN civilization is the direct result of the application of the principles of subdivision of labor. This in turn has resulted in inventions, largely labor-saving; material-handling devices have played an important part in this development. Yet to-day, in spite of equipment and methods now available, material is handled constantly in identically the same manner as in the early stages of civilization.*

Slow Improvement of Material Handling Methods

Why is this? In the opinion of the author it is due to a number of influences, such as:

(1) Ignorance of methods and equipment available; (2) lack of standardization of materials, methods, containers to be handled to permit installation of and economical use of material-handling apparatus; (3) insufficient comparative economic data; (4) improper engineering; (5) poor salesmanship and selling policies, and (6) lack of a central organization to educate the public and to act as a clearing house for economic and technical information.

There has recently been published an encyclopedia of material handling prepared by recognized authorities. This is a step in the right direction and it should prove of considerable assistance, particularly in eliminating ignorance of methods and equipment.

Lack of standardization of containers is a peculiarly potent deterrent to the proper economic solution of material-handling problems, particularly at express and package-freight stations, terminals, transfer points and steamship docks. A proper solution of this important problem would reduce waste due to loss and breakage, waste of transportation space, waste in production, and shipping costs.

It is a well-recognized fact in industrial-plant operation that the last 20 per cent. of operating efficiency is the hardest to obtain, and yet shows the highest return. Thousands of plants in this country do not show an operating efficiency of more than 50 per cent., as compared with those plants that have an operating ratio as high as the present state of the art will permit. There are many reasons for this low operating ratio, but we are concerned only with the losses due to inadequate and inefficient material handling.

Cost Elements

Industrial costs are composed of the following factors:

(1) Material; (2) production labor; (3) factory burden or overhead; (4) general administration expense, and (5) sales expense.

As a usual thing, indirect or non-productive labor is charged out to factory burden. A very large portion

of this labor is used in picking up, putting down and transporting material of all kinds. Hence one place to start in reducing factory burden is to reduce waste of labor and expense in this indirect labor item by substituting adequate and properly adapted material-handling equipment and methods.

Examples of Savings Effected

Some specific cases will help to visualize the situation better.

I. In a large plant in Cleveland, Ohio, 55 men and 25 units are doing the work which today would require 650 men for handling alone, if they reverted to the old methods of five or six years ago.

II. A tractor and 16 trailers reduced the yard gang from 18 to 4 men and eliminated a mile of industrial track, the salvage of which nearly paid for the initial installation.

Mr. Max Sklovsky, chief engineer, Deere & Co., Moline, Ill., after an exhaustive study of material handling in his foundry, recently made the startling statement that he was handling 158 tons of material for every ton of finished casting produced, the figures for 100 tons of castings being as follows:

	Tons
Metals	2,606
Coke and lime	95
Core material	1,278
Molding sand	7,491
Equipment	5,150
Miscellaneous	200
Total	16,820



HAROLD V. COES, M.I.T. '06

Manager, Ford, Bacon & Davis

III. Mr. W. G. Bridgeman, general superintendent, Terminals Operating Co., New York,

cites some interesting comparisons of handling costs at terminals. Two-wheeled trucks were used under the old method, electric tractors in the new method.

Terminal	Tons per man per hr., old method	Tons per man per hr., new method	Cost difference per ton
Wilmington, N. C.	0.873	3.49	\$0.281
South Atlantic port.	1.29	2.72	
Cincinnati	0.722	0.918	0.14
St. Louis	1.2	1.8	

Mr. Bridgeman further states that in his opinion 75 per cent. of the freight houses in the country can increase production per man per hour anywhere from 25 to 100 per cent., and this will be accomplished mainly by the use of mechanical equipment for handling freight.

IV. Mr. J. A. Kreis, Hupp Motor Car Co., Detroit, Mich., states that their 20-ton locomotive crane "not only speeds up handling of material but pays for itself every 4½ months."

V. A battery of 4 Wellman-Seaver-Morgan unloaders can now unload a 10,000-ton ore vessel in 3½ hrs. In the old days, using a clamshell bucket, the cost was

*Presented at annual meeting, December 5-9, American Society of Mechanical Engineers.

around 25 cents per ton; today it is 2½-4 cents per ton. This cost includes overhead, interest on plant investment, and maintenance.

VI. Table 1 is an example of the rehabilitation of a paper mill by material-handling methods. The mill was 60 years old or more, and had grown around itself in a manner that presented a number of problems difficult to solve. After a policy for rehabilitation and extension had been worked out, it was possible to predict future material-handling costs, based upon improvements that would obtain under the rehabilitation plan and application of the proper material-handling equipment to the problems in hand.

If the manufacturer will get the engineer's point of view and the engineer the manufacturer's, and both will get the economic viewpoint, much good will result, fewer mistakes be made, and society and industry will benefit and prosper. By all means, then let us work for right solutions of our material-handling problems. Let us be fair to each other, to ourselves, to the public, to labor, and make one dollar, not ten dollars, do the work of one. A proper attitude of mind in material-handling problems is important.

Initial Solution Not Always Best

The human mind apparently functions in a peculiar

Table 1. Estimated Annual Cost of Present and Proposed Material Handling in a Paper Mill.
(Based on Average Quantities Consumed in Year 1919 and 6 Months 1920.)

Material	Unit	Average Annual Consumption		Present Cost ¹		Estimated New Investment		Proposed Cost ¹		Annual Saving		Equipment Selected
		Consumption	Unit	Total	Unit	Total	Unit	Total	Unit	Total	Total	
Alum	Ton	207		\$10.60		\$2,862		\$1.87		\$505		\$2,357 Locomotive crane and power mule
Ash disposal	Ton	4,800		2.08		10,000		0.42		2,000		5,000 Pneumatic conveyor
Bleach	Ton	875		2.80		2,450		2.00		1,750		700 Locomotive crane and power mule
Clay (China)	Ton	1,800		4.48		8,064		1.60		2,880		5,184 Pneumatic conveyor
Lime	Ton	2,500		1.60		4,000		0.50		1,250		2,500 Pneumatic conveyor
Lumber: Box	M.B.M.	1,000		4.85		4,850		2.25		2,250		2,800 Loco. crane and gravity conveyor
Lumber: Strips	M.B.M.	100		6.00		600		3.50		350		250 Loco. crane and gravity conveyor
Pulp wood	Cord	10,000		4.10		41,000		16.70		16,700		24,300 Loco. crane and pneumatic conveyor
Rosin	Ton	250		6.55		1,637		1.00		250		1,387 Locomotive crane and power mule
Soda ash	Ton	545		2.40		1,310		0.50		273		1,037 Pneumatic conveyor
Sulphite pulp	Ton	5,500		4.10		23,000		1.95		10,550		12,500 Power mule
				\$90,773		\$114,450		\$38,708		\$61,065		

¹The present costs include maintenance and repairs, but no fixed charges, or other overhead items. The proposed costs include fixed charges of 20 per cent.

The table illustrates the varied material to be handled, but one would need to know the physical handicaps at the mill to appreciate fully the necessity for and the difficulty of obtaining a right solution of the problem. The preliminary testing out and checking up of the equipment as installed indicates that the savings will be readily obtained and in some cases exceeded as operating proficiency increases. It can thus be seen that there are opportunities in almost every branch of industry to reduce large wastes in material handling.

The Art Is New and Requires Unbiased Viewpoint

The public, industrial executives and business men generally are not in possession of sufficient data and economic facts to make them realize the astounding wastes going on all around. Engineers and manufacturers are largely to blame for this. The industrial executive usually knows how much per piece or per unit it costs to produce a given article, but rarely knows what it costs per unit to handle the materials entering into the manufacture of the article itself or the cost of handling the finished article.

It is only recently that industrial plants have been designed or laid out on a material-handling basis. The writer knows of plants that do very well in normal times whose physical handicaps due to the absence of any consideration of material-handling in the old days are such that it is a physical and financial impossibility to provide adequate material-handling methods and equipment for them. In many cases like these the savings in labor alone would pay a very substantial part of the fixed charges of a rehabilitated or a new plant.

For instance, a certain modern plant cost, including land, \$1,500,000. It is operating today at about one-third capacity, yet the savings in labor alone pay the annual fixed charges of \$145,000.

In many instances manufacturers of material-handling equipment have been remiss and short-sighted in selecting men of the wrong type to represent them, men in many instances without knowledge or comprehension of the underlying economic laws. Capital wastes, dissatisfaction, and frequently bitterness result from sale of unsuitable, inadequate or incomplete equipment.

manner, particularly in connection with mechanical or technical problems. It seems necessary to start with the complex before the simple can be attained. This characteristic of the mind needs to be watched very closely in its relation of material-handling problems. The problems as usually presented in almost any industrial plant or terminal tend to confuse. The tendency of the mind to see the problem in all its complexities frequently leads to a complicated initial solution, but as a rule these initial solutions are rejected as the simple, less costly and more efficient solution finally evolves. We should analyze the problem, carefully determine the number of transfers and make ourselves find and retain the simple solution. Therefore, we should not be discouraged if the first solution does not yield the estimated savings that it is felt should be secured, but should persevere until a thorough analysis reveals the simple solution.

Lowest Cost the Goal in Handling Materials

The initial test of any method, system or device, should be an economic one. The question of will it pay should not be begged. Capital has been wasted, pioneers discouraged and the public bewildered because of undertakings not conforming to this test.

Mr. Wm. F. Hunt¹ postulates these principles as follows:

(1) In handling material, perform only the handling operations that are absolutely necessary; (2) perform these operations in the way that secures the lowest cost. When a simple plan for handling materials has been developed, the financial returns of the installation will, in the absence of labor difficulties, largely determine the wisdom of the installation. It may pay to install apparatus and it may not, according to conditions such as:

(1) Constancy or intermittency of the work; (2) character of the operation itself; (3) results of analysis which follows herein.

If labor can be saved or manufacturing conditions improved by the use of apparatus for handling material, we readily can determine how much labor will be required by the method proposed. By comparing this

¹ Handling Materials in Factories, Wm. F. Hunt.

method with the present method, we can ascertain the probable labor-saving effected.

The investment justifiable to effect the saving is the item in the investigation that is the most difficult to analyze, as it has so many variables. The figures obtained by the following method are an indication of facts and the ultimate decision must be dictated by good judgment and a general consideration of the whole situation.

How to Arrive at the Best Method

The variables are many in the work to be performed. The work may be of temporary character, infrequently done, the amount fluctuating widely, or it may be a regular daily operation, year in and year out; this item varies from 0 to 100 per cent. If the work is of a temporary nature, no saving can be made, whereas if it is of daily necessity for the future, the whole saving of reduced labor by the plan suggested is available. The true value exists somewhere between these two extremes, and it need not be difficult to assign a value to this item after thorough observation and careful consideration. Let us call it X per cent.

The variables in the investment value may be classed as follows:

A =interest charges on investment, per cent.

B =interest to provide for upkeep of apparatus installed.

C =interest to provide for depreciation due to age, per cent.

D =interest to provide for progress in the art of the particular device proposed (subsequent inventions), per cent.

E =interest to provide for extensions to service, per cent.

H =additional superintendence and overhead expenses due to change in method, per cent.

K =interest to provide for taxes, per cent.

F =cost of power, supplies and other variable items in dollars per year

Let S =yearly saving in labor in dollars

and Z =investment in dollars justified by the foregoing considerations

$$\text{then } Z = \frac{S (X \text{ per cent}) - F}{(A + B + C + D + E + H + K) \text{ per cent}}$$

Working this out for an assumed set of conditions, assume that the work which under the present methods of moving materials requires four men employed at \$3 per day, 300 days per year, at a yearly cost of \$3,600, can be done according to the new method by one man, costing \$900, thus saving \$2,700 per year. The plant operates on shift, men employed 80 per cent. of the year.

Then $X=80$ per cent $C=15$ per cent $H=3$ per cent

$S=\$2,700$ $D=10$ per cent $K=3$ per cent

$A=6$ per cent $E=3$ per cent $F=\$400$

$B=20$ per cent

$$\text{and } Z = \frac{(\$2,700 \times 0.80) - 400}{0.60} = \$2,933.33$$

This means, then, that equipment costing under \$2,900 will earn maintenance, interest, depreciation, obsolescence and tax charges and show a saving besides.

Assuming that an electric-storage-battery industrial truck costing \$1,750 will meet the conditions, the yearly operating cost would be as follows:

I =cost of equipment=\$1,750

Y =yearly operating cost

$=I(A + B + C + D + E + H + K) \times F$

Then $=(\$1,750 \times 0.60) + 400 = \$1,450$

$S=\$2,700 - \$1,450 = \$1,250$

This is an actual saving of \$1,250 a year, a return of approximately 71 per cent. on the investment over and above all interest charges, upkeep, deterioration and obsolescence.

Only by some such analysis can a real solution of the problem be obtained. Unfortunately salesmen in their eagerness to take orders, and managers in their ignorance of the underlying conditions, sometimes over-

look some of the factors in the problem with the result that anticipated savings are not obtained.

Too much thought and consideration cannot be given to the selection of equipment that not only shows a saving but fits into the general operating conditions of the plant, or suits physical conditions imposed by plant or location, and yet at the same time fits into plans for future extension, development or rehabilitation of the plant. A \$25,000 locomotive crane will last a long time if properly cared for. If future development of the plant does not provide space enough for the utilization of the crane to its best advantage, then the crane may not be the piece of equipment to select initially, even though it will satisfy all of the initial conditions.

Dr. S. K. Loy, chief chemist, Rocky Mountain Division, Standard Oil Company (Inc.), Casper, Wyo., and Dr. F. E. Knoch, superintendent United Oil Company, Florence, Colo., have been appointed consulting chemists of the U. S. Bureau of Mines in the investigations by the Bureau of Colorado and Utah oil shales at its Boulder and Salt Lake stations.

* * *

Stevens Institute of Technology, Hoboken, N. J., celebrated the 50th anniversary of its founding at a dinner at Hotel Astor, New York, on December 15. Notable was the attendance of the entire class of 1877, which numbered ten, and included L. H. Nash and A. G. Brinkerhoff, respectively president and secretary, Nash Engineering Company, South Norwalk, Pa., whose products are well known in the chemical industry.

* * *

The acquirement of control of the American Brass Co., the largest consumers of copper, by the Anaconda Copper Co., the largest producer of copper, is a notable example of current developments under the statute in the direction of waste elimination in industry. Another example is the project of consolidation of a number of independent fertilizer concerns under consideration by a committee headed by C. Wilbur Miller, president of the Davison Chemical Co., Baltimore, Md. This proposed integration is the result of the extreme depression which has pervaded the fertilizer industry.

* * *

Plans for the resumption of operations in the synthetic camphor factory of the E. I. du Pont de Nemours & Co., Inc., at Deepwater Point, N. J., have been under discussion by large consumers of this product and officials of the du Pont company. The Deepwater plant has a capacity large enough to meet the requirements of the pyroxylin plastic manufacturers of the United States. These manufacturers were represented at the conference by N. M. Clark, vice-president of the Celluloid Co.; H. R. Bemis, treasurer of the Fiberloid Corp., and B. W. Doyle, treasurer of the Visceloid Co.

* * *

The annual meeting of the American Institute of Fertilizer Chemists was held December 3, at Atlanta, Ga., at which twenty commercial laboratories specializing in fertilizer raw materials and fertilizers were represented. W. J. Gascoyne, Jr., Baltimore, Md., was elected secretary and treasurer. Under the direction of Dr. F. L. Parker, of Charleston, S. C., president, the meeting considered scientific and commercial problems affecting the practice of fertilizer chemistry. The following committees were appointed: Co-operative Work—H. B. Battle, chairman, P. McG. Shuey, A. M. Lloyd, D. C. Picard, G. W. Agee, J. H. Pratt and J. Q. Burton; Scientific Programs and Problems—W. C. Dumas, chairman, Chas. W. Rice and M. H. Coblenz.

Chemical Department of The Newport Company

THE NEWPORT COMPANY is the projection of the Schlesinger "interests," dominated by the Milwaukee Coke & Gas Co., into the field of fine chemical manufacture, and completes the sequence from coal mining to the production of dyestuffs and pharmaceuticals.

The fact that one organization should be directly responsible from the mining of the basic raw material to the marketing of the finished product is in itself unique from the standpoint of manufacturing accomplishment.

George E. Burd, general superintendent of the plant, which is located on the shore of Lake Michigan, 12 miles south of Milwaukee, Wisconsin, described in September, 1920 *CHEMICAL AGE* the construction and equipment of the new chemical laboratory; which imposing structure, among the foremost of its kind in the country, reflects a three-years' growth of the chemical department from seven wooden desks and a balance room, and as well a corresponding development of the coal-tar chemical production activities of the organization. A pay-roll of 2,100 men is significant of the credit due the enterprise and ability of technical men who have created a great industry out of the elaboration of the crude by-products of coke and gas manufacture.

Chemical Control

The chemical department is under the control of Dr. I. Gubelmann, chemical director, and Dr. J. B. Oesch, chief of research, whose offices are in the new laboratory structure, centrally located within the Carrollville plant, to which is given the name, Experimental and Research Station.

Dr. Gubelmann, besides being in charge of the chemical department of the company, also has important duties to perform in co-operation with the engineering and sales departments and also in deciding the general chemical policy of the company. Dr. Oesch is responsible for the management of the research work and for

the establishment of new processes on a plant scale until they are handed over to the operating departments.

The proximity of the research laboratories to the various plant units enables the research department to procure rapid and efficient plant control and also a steady supply of plant products necessary for its work. Practically every device necessary for the carrying out of chemical research has been provided. An extensive and up-to-date library affords ample opportunity to the chemical staff to keep in touch with the patent and journalistic literature.

Experimental Station includes a dye-testing laboratory and a well-fitted, small scale plant so that experimental work on quality, yields, apparatus, costs, etc., can be carried out on a scale comparable to that in actual manufacture.

Chief Chemists

The Research and Experimental organization is subdivided into various sections, each under the supervision of a chief chemist, who, besides being familiar with the fundamental principles of tinctorial chemistry, is thoroughly conversant with the chemistry and recent advances of his special branch of the subject.

The following sections may be cited: Basic Intermediates (benzol, toluol, xylol derivatives); Naphthalene Intermediates; Anthraquinone Intermediates and Vat Colors; Azo Dyes; Triphenylmethane (Azine, Oxazine, etc.) Dyes; Sulphur Dyes; Anthraquinone Acid Dyes; Inorganic Section; Analytical Section; and Dye-testing Section.

The duties of chemists in charge of the Research sections are by no means confined to the laboratory. With the assistance of a staff of chemists working under their supervision, processes for the preparation of intermediates and dyestuffs are worked out in the laboratory, where particular attention is devoted to the practicability and economy of the method. They are then elaborated on a larger scale in the technical research laboratory and



IVAN GUBELMANN
Swiss Technical University, Zurich
Chemical Director



R. J. GOODRICH, B.Sc.
University of Illinois

RUDOLF VETTER, Ph.D.
Technical University of Charlottenburg, Berlin

P. H. STOTT, B.Sc.
Victoria University, Manchester

W. BRAENDLI, Ph.D.
Swiss Technical University, Zurich

CHIEF CHEMISTS, THE NEWPORT COMPANY

having been found to give satisfactory results are finally transferred to the plant. It is here that the intimate knowledge and experience gained by the research chemist of the various peculiarities and precautions to be taken in the working out of the process, are of the utmost value in enabling him to direct the operations of the initial runs in the plant and to nurse the operation until the plant operators no longer need his assistance.

This having been done and the process working smoothly, the responsibility of the manufacture no longer rests with the Research Department unless unforeseen difficulties arise in the manufacture, in which case the assistance of the research chemists is again required. During the elaboration of such processes and also as control over the works' products, the services of the analytical and dye-testing laboratories are of the utmost value in estimating the purity and quality of finished products and raw materials.

The importance of conducting research work in new fields has always been a feature of the company's program, with the result that the near future will witness the production of entirely new dyestuffs of great value to the textile trade.

Another important duty of the Chemical Department is to co-operate with the Engineering and Constructional Departments with regard to the design of new experimental apparatus and plant equipment for new processes which have passed experimental stage.

Illustrative of the team work and company loyalty of the Newport Company's organization is the Newport Chemists' Association, whose membership is made up of men in active charge of the divisions of the chemical control, research and operating departments.

This organization meets periodically to cultivate good fellowship and to discuss the related problems of the daily work, and is a most excellent instrument for the promotion of efficiency which finds expression in lower production costs, improved morale and the recognition of capacity. The officers are: Pres., Dr. O. Frey; vice-pres., N. C. Davidson; treas., H. Marter; secy., Dr. H. Weiland.

Instruction in Industrial Publishing

The New York Business Publishers Association, Robert H. McCready, president, announces the establishment of a Course in Industrial Publishing. The course has been organized and will be conducted under the direction of the Educational Committee of the Association by the Business Training Corporation, 185 Madison Ave., New York, which has been retained for that purpose. It will include lectures, conferences, text-books, problems, and a personal commenting service. Classes are now being organized in New York and will soon be organized in other publishing centers. The course will also be conducted by correspondence for people who are unable to attend classes.

Although the course is designed primarily for the benefit of members of the editorial and business staffs of trade and technical periodicals, it will be open to all who are interested in the field.

Among the topics covered are: Distinctive features of industrial publishing; its code of ethics; personal qualities required for success; determining editorial policies; getting the right kind of articles; securing accurate reports and data; writing for industrial papers; building up circulation; creating advertising; departmental management; service to the industry; service to advertisers; basic policies and tendencies.

"We look upon this undertaking," said H. M. Swetland, president of the United Publishers Corporation and chairman of the Educational committee, "as one of the most important steps ever taken toward making industrial papers even more valuable to their readers and advertisers. Our own prosperity will grow in direct proportion to our growth in ability to render useful service. It will help us all to gain a broader and more accurate knowledge of the fundamentals of the business; it will provide a sound and thorough training of those who are coming along on our papers; and it will serve to attract and develop new men for us from the industries."



J. B. OESCH, Ph.D.
University of Zurich
Chief of Research

W. M. MURCH, B.Sc.
Brown University



J. OGILVIE, B.Sc., F.I.C.
University of Edinburgh



H. R. LEE, B.Sc.
University of Illinois



L. F. KOBERLEIN



H. J. WEILAND, Ph.D.
University of Illinois

CHIEF CHEMISTS, THE NEWPORT COMPANY

Procedure in Lead Arsenate Manufacture

By Dr. Robert E. Wilson

Director of Research, Laboratory of Applied Chemistry,
Massachusetts Institute of Technology

IMPROVED procedure in the manufacture of lead arsenate which has for its object a product capable of remaining in suspension in water for extraordinary periods without any noticeable or objectionable settling of the suspended particles, is the subject of recent letters patent* of interest to insecticide manufacturers.

My investigations have led to the discovery that the settling of insecticides consisting of either the acid arsenate of lead (PbHAsO_4) or the normal arsenate of lead $\text{Pb}_3(\text{AsO}_4)_2$ is due to the clustering or clumping of the particles, however fine the individual particles may be, and that such clusters often contain one hundred thousand or more separate particles. This phenomenon has been determined from calculations based on the rate of settling and qualitatively confirmed by observation under an unusually high-power microscope.

As a consequence of this tendency of the particles, apparently crystals, of lead arsenate to cluster, the rate of settling of many lead arsenate products on the market at the present time is enormously greater than would be the case were the clustering tendency of the individual particles overcome or at least substantially inhibited.

Heretofore attempts have been made to prevent the settling of the particles of lead arsenate by reducing the size of the particles, the same being accomplished either by fine grinding or by specially manipulating the precipitation of the lead arsenate in the course of manufacture. This latter procedure, it is claimed, resulted in decreasing the settling tendency of a 250 cc. column of $1\frac{1}{2}$ inches diameter of a specified quantity of lead arsenate during the first ten-minute period by some 70 seconds.

I have discovered that relatively minute quantities of materials capable of serving as protective colloids will, when dissolved in water and added to the bath in which the lead arsenate is precipitated either prior to or during the precipitation, or even following the precipitation, effect a de-clustering action with the consequence that the product when shaken up with water shows scarcely any tendency to settle in so far as leaving a clear layer at the upper end of the mixture is concerned, even after one-half hour or more, whereas some of the best products heretofore obtained settled so as to leave a substantially clear layer above the settled particles at the rate of about one-half inch per minute.

The preferred protective colloid employed by me is ordinary glue in the proportion of 1-50 per cent. to 25-50 per cent., as the same is not acted upon by the chemicals during the process of manufacture. Accordingly it can be introduced prior to or during the precipitation stage, with the result that a more complete and uniform mixture of the agent employed with the particles of lead arsenate is effected, whereby individual particles become coated with the agent before any appreciable clustering occurs.

While I prefer to employ ordinary glue, or if desired gelatin, other organic bodies of high molecular weight are also adapted to serve the purposes accomplished by the gelatin. Such bodies as tannin and pyrogallol may also be used, the same being preferably added after precipitation of the lead arsenate, and in fact any or-

ganic body which is capable of serving as a protective colloid and thus greatly inhibit the clustering of the lead arsenate particles when in water suspension, may be employed without departing from the spirit of my invention.

I have ascertained that alkalis, such as caustic alkalis, when employed in the proportion of about 1-10 per cent. in lieu of my organic agents, will inhibit the settling to a limited extent, about 25 per cent. for example, and on the other hand that inorganic acids, as sulfuric acid when present in amounts of 1 per cent., greatly increase the tendency of the lead arsenate to settle.

Wherever I have referred to percentage in connection with the de-clustering agent the same is based on the weight of lead arsenate present in the mixture.

My improved product may be reduced to dryness and marketed as a dry powder. Its insecticidal power is unimpaired. It will keep almost indefinitely and will possess much greater covering properties than ordinary lead arsenate powders, with the consequence that it will be more effective and economical to use.

Organic compounds, such as glue or gelatin which are relatively chemically inert because of being neither acid nor basic, are particularly desirable for the reason that they exert their protective action even in the presence of considerable amount of basic impurities often present in lead arsenate.

A Common Observation

Observation of technical men seems to warrant the opinion that a great many of them become too technical to be good business men. The college courses in business administration are a step along the right line, but it is uncertain as to the extent of their effectiveness. It is unnecessary to say that the larger the business organization in which a technical man finds himself the easier it is for him to closely specialize, thereby losing the opportunity to gain any well-rounded business experience.

It is advisable, therefore, that young and ambitious technical men should affiliate with young or new companies in which their services will gain immediate recognition, and their opportunities will be more abundant. Today chemical engineering offers the very best field for any young man with good technical bent and training.

Such a man does not justify his position unless he understands very much more than the technical side of the industry in which he is engaged. He must broaden out and understand the entire business or he will not have the power of initiative which is so essential to progress.—M. M. D. in *Cotton Oil Press*.

Alanson B. Houghton of the Corning Glass Works, Corning, N. Y., member of the House of Representatives, is reported to have been decided upon as U. S. Ambassador to Germany.

* * *

H. H. S. Handy has resigned as director and vice-president of the Allied Chemical & Dye Corp., 61 Broadway, New York. He is succeeded by Dr. William G. Beckers.

* U. S. Letters Patent No. 1,899,374 issued Oct. 11, 1931 to Robert E. Wilson, and by him assigned to the Pyralongel Plate Glass Co. from which this description is adapted.

What I Saw In Germany

By Robert H. McCready

President, McCready Publishing Co.

IARRIVED in Germany with three definite ideas:—the first was my own and was to the effect that in some way or other the exchange value of the German mark was being purposely depreciated. The other two were a result of what had appeared in the newspapers, viz., that cows were scarce in Germany and that the people were hungry if not starving.

The question of the cows was quickly settled on a trip of fifty miles between Cuxhaven and Hamburg, when I counted more than twelve hundred of these useful animals grazing within a quarter mile of the tracks. In many other parts of Germany cows were seen in apparent abundance and in nearly the same proportion that they would be found in a country such as our own.

No Under-Nourishment

Careful search for starvation or even hunger was useless—almost ludicrous. The people of Germany today are well-fed. The men are fat and prosperous-looking. The children are well-nourished. In every city visited, restaurants, cafes and beer-halls were crowded four times a day. Food is plentiful and not nearly as high-priced as one would suppose. The effect of the war in Germany is more visible on the faces of the women than anywhere else. The people themselves are busy, apparently contented and bound to enjoy the good things of life, such as plenty of food, good clothing, theatres, drinking, etc.

The first question to present itself was: Where does all of this money come from? It is certain that in the greater part of Germany the cost of living has increased more rapidly than wages. Statistics furnished by the Government point in the other direction, but actual facts show conclusively that while wages have risen to 10-15 times pre-war levels, the cost of food, clothing and other necessities of life, with the exception of rent, has advanced somewhat more rapidly.

Everybody Works or Speculates

Practically everybody in Germany works; with the exception of children under sixteen there is hardly an idle person in the entire country. The women do a large part of the agricultural work in the same way they always have done, but to a greater extent. Large numbers of city dwellers rent small pieces of land in the suburbs which are farmed intensively by the women of the families. These bits of land are depended upon to supply potatoes, turnips and other vegetables, as well as meat in the shape of rabbits, poultry and pork. Many of the men engage in some kind of business outside of their regular pursuits. A bank clerk may give music lessons, a railroad employee conduct a small-scale wholesale tobacco business, etc.

The most usual method of increasing the income, however, is by speculation in foreign exchange and industrial stocks. As long as the mark was on a steady downward march, it was a simple matter to purchase foreign exchange, selling it later and getting more marks than were paid for it.

The same method was applied to industrial stocks, which representing concrete capital increased in price as the mark fell. In this way it was possible for a clerk earning 1500-2000 marks a month to live in a way which was apparently far beyond his means.

German Organization

The most outstanding feature of industrial Germany today is the perfection of her organizations. Every worker from waiters, car-drivers and chamber-maids to the head managers in the big industrial plants belongs to a union of one kind or another. These unions are apparently all-embracing and are grouped together by communities, then by districts, and finally in a central organization in Berlin. The employers have organizations along similar lines so that collective bargaining is done on a community scale rather than by separate units. Taking as an example the question of office workers, salespeople, etc.—in the city of Nuremberg the collective bargaining is done by some thirty odd labor organizations working together on the one side and a group of employers' associations on the other.

By these methods the so-called "tariff" is worked out. This tariff is a most interesting combination. It starts with a minimum wage and then advances by different amounts in accordance with the age of the worker and the number of years he has been engaged in his or her occupation. There is a different rate of payment for a married man supporting one or more people and that of an unmarried man. The women have a grading of their own and with them also the married woman who has someone to support is paid more than the unmarried woman or the married woman who has no one dependent upon her. Piece work is being introduced in many factories and as a rule the regulation is that piece workers be guaranteed 25 per cent above the minimum tariff rates.

Export Methods

There is a growing tendency to control exportation of merchandise not only as to the goods, but as to the prices and methods of payment. All of these are under the jurisdiction of what is known as Ausfuerguts Kontrolle, which is a government body located in Berlin. The various industries are under control of subdivisions or committees of the central body.

These committees are composed of prominent manu-



ROBERT H. MCCREADY

President, McCready Publishing Co.

facturers in the lines over which the committee exercises control. Endeavors are being made to regulate exportation of goods so that payment shall be made in the currency of the country to which the goods are exported and the goods sold at a price comparable to the ruling price in that country. Thus, merchandise sold in Holland would be paid for in gulden and the price would be that at which similar merchandise is selling in Holland, less a reasonable percentage of profit for the wholesaler and retailer. When lines of merchandise are thus controlled, the exporter must submit his bill to the committee. The committee decides as to whether or not the price is fair, and if this is decided favorably an export permit is issued. The difference between the German price and the export price is in many cases made up partly by an export duty so that a portion of the additional price goes directly to the Government.

Sequestration of Capital in Foreign Countries

It has become very widely known that the business assets of Germany are being kept in foreign countries. This is done partly by purchase of foreign exchange and partly by allowing credits to remain in the countries where goods are sold. In this way enormous funds have been made available in cities such as Rotterdam, Amsterdam, Stockholm, London and New York.

Under such conditions where German capital is allowed to remain in foreign countries and where speculation in foreign exchange is an almost universal practice, it is no wonder that the value of the mark kept declining for such a long time. The German people realized that at stated intervals it would be necessary for the Government to purchase foreign exchange in order to meet reparation payments and they knew that when these purchases were going on they could sell their foreign funds to their own individual advantage.

Centralized Economic Control

Industrially and financially Germany is guided and controlled by a very small group of men. The great financial institutions, Deutsche Bank, Dresdner Bank, Darmstädter Bank and Disconto Gesellschaft, have representation in the directorates of practically every one of the German syndicates and commercial companies. It has been stated that a group of from nine to a dozen men could speak authoritatively and finally for industrial and financial Germany.

It is not to be supposed that men of this character are in sympathy with socialism or a socialistic government. Controlling as they do the manufactures and finances of the country, they are in position to give an object lesson to the people which cannot fail to have an effect. They also are in a position to give an object lesson to the world at large. On every hand one meets with the expressions: "Germany cannot pay her reparations"; "Germany will go bankrupt"; "There will be another war if the German people are driven to the wall by enforced payment of reparation." The steadily declining mark is pointed to as an indication of what is happening. "Germany will be another Austria," say they, and "if Germany does travel the road that Austria has travelled, Europe will be thrown into financial chaos."

German Disturbance of World Trade

Another important feature of the situation is the fact that Germany possesses the best facilities for trading with Russia, Poland, Czecho-Slovakia and other eastern countries. The prospect of this rich harvest is dangled before the eyes of business men in the allied nations as an inducement to a reparation moratorium and a reduction of the amounts to be paid.

There is no doubt that German goods sold on a basis

of a rapidly depreciating mark are causing havoc in industry in England, France and other countries. Thousands of buyers have been pouring into Germany purchasing goods at wholesale and retail, and as a result workmen in other countries are finding themselves out of employment. The object lesson is having its effect. There is every reason to believe that within a very short time some method will be found to prevent the further disturbance of world exchange and demoralization of industry. At the present time conferences to deal with these questions are being arranged.

There is no doubt that German commercial interests are investing largely in foreign lands. They are buying factories in England, France (especially Alsace-Lorraine), Italy, Spain and the United States. As one prominent German said to me—"The French do not know how to run the industries of Alsace-Lorraine. We do. When the French find they are losing money, or get tired of running a factory, and it comes on the market, people who have means are buying, and we are taking care that what happened to our foreign factories in 1914 will not happen again."

It would seem from this statement that investments in foreign lands are being made in the names of citizens without any tinge of German blood.

Is Germany bankrupt or going into bankruptcy? By all means, No! The German people are on a sounder basis than those of any other country in Europe. Their industries are in better shape. They are working at full capacity. They are investing their funds in safe places. Financially the German Government may go bankrupt; the mark may become absolutely worthless; German bonds may have no more value than a scrap of paper, but the German land, the German factories and the German people themselves are fundamentally and economically sound. On the first of October there were only 138,000 people out of work. This is below any pre-war figures.

Various plans are mentioned and predictions made of the economic and financial future of the country. The most general belief is that there will be a postponement of reparation payments, a scaling down of the reparations and a thorough overhauling of the budget, taxation and government-owned industries.

German Government

There is a very widespread belief among well-informed people that Germany will in time return to a monarchical form of government. Having heard from very reliable sources that such a thing was out of the question, I could not understand the expressions of opinion which I got at first hand in Berlin and in other large German cities. Finally, however, I learned the solution, Germany will never return to the Hohenzollern rule. The Kaiser is hated almost throughout the length and breadth of the land. The German people brought up from childhood to hate a coward and to regard suicide as the proper end of failure, has nothing but scorn and disdain for the Kaiser who on the eve of defeat sneaked across the border into Holland—hid himself behind a wire fence and grew a beard. William of Hohenzollern in his military trappings and upturned mustache, a prisoner on the Island of St. Helena, would have been a source of danger and the rallying-point for a revolution. William Hohenzollern hiding in a Dutch castle stands no chance of returning to the throne of Germany.

The National Wood Chemical Association, composed of concerns engaged in the production of methanol, acetate of lime, acetic acid, etc., from wood, held a meeting, December 15, at Buffalo, N. Y.

Annual Report of the Bureau of Chemistry

A Survey and Summary of the Administration of Dr. Carl L. Alsberg

THE report of the work of the Bureau of Chemistry for the fiscal year ended June 30, 1921, is notable in that, in addition to the resumé of the year's work in this largest and most important branch of governmental activity in scientific and industrial research, it is a narrative of the development of the Bureau of Chemistry during the incumbency of Dr. Carl L. Alsberg, now director, department of production and distribution, Food Research Institute, Stanford University.

When, about January 1, 1913, the Bureau of Chemistry passed to new leadership two tasks in general confronted the new chief.* One was to improve the character and volume of the bureau's scientific research; the other was to make the enforcement of the food and drugs act more effective through the establishment of satisfactory cooperative relations with food and drug law enforcing officials in the States and municipalities, as well as through the development of greater uniformity in the exercise of food and drug control throughout the country.

That the scientific research work of the bureau had lagged grew out of the fact that agricultural chemistry as a distinct and independent science had lost ground the world over, and that Congress had placed upon the Bureau of Chemistry the responsibility of enforcing the food and drugs act.

Origin and Growth of the Bureau's Work

When the Division of Chemistry, out of which the Bureau of Chemistry grew, was established in the days when the Department of Agriculture was still a commission, agricultural chemistry was recognized as a definite, distinct science. In the course of time the field covered by it grew so wide, so diverse, that it became split into many special subjects. The result was that the various other bureaus of the department gradually established their own chemical laboratories. For example, the Bureau of Soils deals with the whole of soil chemistry and with the chemistry of the fertilizer industry, the Bureau of Animal Industry with the chemistry of milk production and animal nutrition, the Forest Service with the chemistry of wood and of the industries that use wood as their raw materials. Even the Bureau of Plant Industry, while it has established no extensive purely chemical laboratories, employs some chemists in its various divisions.

Such was the state of affairs in 1913, and such, to a considerable degree, it still is. Much of the field of research occupied by the Bureau of Chemistry until 1900 was in this manner lost to it. The question that had then to be faced in 1913 was into what channels should the scientific research of the Bureau of Chemistry be directed, that it might be of the greatest service to the country and to the Department of Agriculture.

Now the object of agriculture is to feed and clothe the Nation in the best way possible, and it is for the promotion of these ends that the Department of Agriculture exists. To accomplish these ends the promotion of production is not enough. The improvement of distribution and that of utilization are equally important. It is obvious that better or more economical utilization is equivalent to an increase of production. Since the improvement of the methods of utilizing agricultural products is of vital importance not merely to the farmer but to the whole country, it was decided in formulating

the research policies of the Bureau of Chemistry to study the industries that utilize agricultural products, as well as to endeavor to create new or enlarge existing outlets for such products. This involved the development of a portion of the Bureau of Chemistry as a utilization service. Such a bureau, dealing with many of the industries that use agricultural products as their raw material, might be made extremely useful not merely to the agricultural interests but to the country as a whole. Since its work must articulate intimately with the production of agricultural raw materials, it can not be effective if placed elsewhere than in the Department of Agriculture.

New Uses for Agricultural Products

The establishment of an industrial outlet for an agricultural product mainly used for food purposes may act as a stabilizer upon production and prices, since the consumption as food of such a product can not be increased largely in a year of great crop yields nor largely diminished in a year of scanty harvests. Factories, however, can operate below capacity when their raw material is scarce and high priced or work overtime when it is abundant and cheap, thus acting as a flywheel on the machinery of production and consumption.

In this manner the manufacture of alcohol, starch, glucose, and dextrin has served to help in preventing gluts of potatoes in certain European countries. Had there been for corn an outlet of this general character, capable of utilizing an appreciable part of the crop, it might well have been of inestimable value to the corn-belt farmer during the past year. In the same way the development of a new outlet for a crop may mean much to the United States. Thus the area of land that can be kept under cultivation in much of the semiarid portion of the country is dependent upon the price of the grain sorghums. If it were possible to use industrially a considerable portion of the crop, for example, in the manufacture of starch, alcohol, glucose, oil, and by-product feeds, the result would be, inevitably, to bring land that can not now be farmed under the plow.

Since 1913 much work of this type has been undertaken in the Bureau of Chemistry. That more has not been accomplished is due to the Great War which kept adequate funds from being made available and caused the loss of a very large proportion of the bureau's ablest scientists.

Office of Development Work

It is often a difficult problem to introduce into practical use scientific discoveries, especially when, as in the Government service, their employment in the industries and the arts brings to the discoverer no material reward. Discoveries of great practical value not infrequently remain unused.

To meet this situation, so far as the work of the scientists of the Bureau of Chemistry is concerned, an office of development work was created. As the introduction into practical use of scientific discoveries is, in the majority of cases, a matter of engineering rather than of pure science, engineers form the staff of this unit. The establishment of this office has amply justified itself and its services have been requisitioned by other bureaus of the Department of Agriculture. It is not proposed that it shall ever develop and introduce into practice inventions made outside the Government service.

* From Report of Bureau of Chemistry, U. S. Department of Agriculture, July 1, 1921.

Biochemistry—Original Research

Agriculture is a biological science. Even the soil teems with life. Therefore it has been the aim to develop the Bureau of Chemistry not merely as an agricultural products utilization service but also as a bureau of biochemistry. Biochemical research has been emphasized especially since 1913. To this end much of the work of the various laboratories was given a biochemical direction and in addition a protein investigation laboratory, phytochemical laboratory, microbiological laboratory, and pharmacognosy laboratory were established.

In order that the food and drugs act may be enforced effectively much original research is necessary. Few of the State or municipal officials have the opportunity, the staff, or the facilities for carrying out such researches, and they look to the Bureau of Chemistry for much of the information they require.

Such regulatory investigations may in general be divided into four categories:

- (1) The devising of analytical methods for the detection of sophistication.
- (2) The determination of the normal range of composition of foods and drugs in order that deviations from the normal due to sophistication may be recognized.
- (3) Investigations to determine whether or not certain substances added to or accidentally contaminating foods are injurious to health.
- (4) Investigations for the improvement, control, or standardization of methods of food and drug manufacture so that manufacturers may learn to avoid inefficient and insanitary methods, very frequent causes of violation of the law.

The last of these four types of investigations, since it aims to prevent and anticipate violations of the law, is essentially similar to and indeed might be classed with the utilization investigations previously discussed.

Organic Chemistry

Many of these investigations demand the employment of the methods of organic chemistry. In consequence the Bureau of Chemistry has gradually developed a large staff of organic chemists until it has come to be the chief scientific service of the Government in organic chemistry. This has resulted in the establishment of numerous contacts with that branch of the chemical industry which deals with organic substances. Such contacts were inevitable, since foods, medicines, and dyestuffs are, or consist largely of, organic substances.

Since the bureau administers the food and drugs act, it has long borne as close relations to the pharmaceutical as to the food industry. With the dye industry it also long has had intimate relations, both because of its investigations upon the use of aniline dyes to color foods and because of its system of certifying to the industry certain dyes as fit for use in food. It was therefore logical for Congress in 1916 to make an appropriation for the conduct of investigations to assist the budding American dye industry, for by that time the Bureau of Chemistry had achieved very definite recognition by chemists for its researches in organic chemistry.

Despite the many adverse conditions created by the war the net result of the policies just outlined has been such a notable improvement in the quality and the volume of the bureau's scientific work that, during the fiscal year 1921, 140 scientific contributions were made to various technical journals. In addition, 7 department bulletins, 3 farmers' bulletins, and 3 department circulars were published and 1 department bulletin was issued jointly with another bureau. At the beginning of the fiscal year 15 applications for public service patents were pending. Eight additional applications

were filed during the year; 6 were granted, 6 denied, and 11 are pending.

Growth of Responsibilities— Specialization of Functions

The responsibility for the enforcement of the food and drugs act placed upon the bureau by Congress necessarily retarded temporarily the bureau's research work because the organization of the administration of the law required, for a time at least, the services of the best minds in the bureau. It drew many of the ablest scientists into executive work and caused a sudden mushroomlike growth of the staff. Such growth always brings complications in its train. In 1913 the research functions and the regulatory functions were intimately mixed, and one was interfering with the other.

Experience has shown that the same individual can not at the same time do scientific research and regulatory work and do them both well. The demands of regulatory work are immediate, those of scientific research remote. Usually research is sacrificed. Moreover, rarely is one person capable of performing both types of work equally well. Apparently one demands a different kind of mind than the other. The situation was cured, simply, effectively, and permanently, by dividing the staff into two fairly distinct services, a research and a regulatory branch. Thus only in exceptional cases has the same individual both research and regulatory duties to perform.

Such an arrangement is far preferable to the segregation of the two kinds of work in distinct bureaus. Regulatory work disconnected from research becomes wooden and unconstructive. Therefore, a purely regulatory bureau will in time develop its own research service with resulting duplications, conflicts, and vexations. Moreover, the regulatory work uncovers important problems which can be turned over to the research service for solution if both services are closely associated. Thus each service stimulates and vitalizes the other.

Finally, there is the very practical consideration that men in the research service who fail to demonstrate originality may be transferred to the regulatory service where they frequently develop into excellent analysts or first-rate executives, while those in the regulatory service who show scientific originality may be recruited into the research service. Under conditions as they exist in the bureau to-day the value of both kinds of work is recognized and, while they are separated as far as practicable, the closest cooperation between the two services exists.

Sequelae of Law Enforcement

It has been the aim to administer the food and drugs act in such a manner as not merely to protect the consumer but also to improve conditions in industry. A vast amount of educational work has been done among producers. Many investigations have been carried on to demonstrate to them methods of better sanitation, of eliminating waste, of utilizing by-products, and of more efficient operation. Unfortunately, although the net result of this work has been large, it is of a character that can not be expressed in figures. It is, however, fair to say that to-day there is hardly a branch of the food industry that would care to return to the days of untrammelled operations which existed before the enactment of the law.

The bureau has been the country's most important training school for food and drug technologists. Many of its scientists have entered the employ of food or drug manufacturers where they have been instrumental in

establishing constructive cooperation with the bureau. In many instances manufacturers have sent their technologists to the laboratories of the bureau to acquire special experience not readily obtainable elsewhere. Finally, the bureau in various ways has succeeded in making manufacturers realize that they must undertake research if their enterprises are to continue to progress. It has succeeded in making groups of manufacturers realize that it is a good business for an industry to police itself effectively, thus reducing to a minimum the necessity for Government interference.

In 1913 both officials and manufacturers complained greatly of the lack of uniformity in the exercise of food control by the Federal and State Governments. Lack of uniformity increases the costs of doing business, and the increased cost is usually passed on to the consumer. It arises not merely from differences in the various laws but also from differences in the interpretation of the laws by the officials and in the application by them of different standards to the same product in different jurisdictions. To meet this situation in part, the co-operation of the Association of American Dairy, Food, and Drug Officials and of the Association of Official Agricultural Chemists was sought. A joint committee on definitions and standards has proposed for the guidance of officials definitions and standards covering a wide range of products which have been adopted almost universally. Thus one cause of lack of uniformity has been eliminated to a large extent.

Lack of uniform action on the part of officials and legislators is due not infrequently to lack of information. There was need in 1913 for some sort of clearing house for the exchange of regulatory information, not merely that in the files of the Bureau of Chemistry, but also that in the files of the various State and municipal departments and printed in journals, bulletins, and reports the world over. There was need for the elimination of a vast amount of duplications and wasted effort due to the fact that officials were not in touch with their colleagues in other localities. Therefore the office of State cooperation was established in the Bureau of Chemistry and the food commissioner of the State of Texas called to take charge. This office has been very successful in drawing officials together, in disseminating information, in securing uniformity, and in establishing effective co-operation among the officials of the country. At the same time the bureau has welcomed such officials into its laboratories, which in many instances have served as a training school for them.

It may, therefore, be asserted in all fairness that since 1913 there has been a steady improvement in the bureau's research work, in its administration of the law, and in its general usefulness to the country as a whole. Such improvements as have been brought about have been accomplished in the face of the very adverse conditions created by the war. In times of war and reconstruction adequate funds are not available and it is almost impossible to recruit highly trained men.

Departmental Activities of the Bureau

Food and Drugs.—Following upon the segregation of research from regulatory work was the decentralization of the latter, whereby chemists best qualified for the responsibilities of inspection and regulation were stationed in the field while the Washington force became the supervising and planning department. The field force comprises chemists stationed in 16 different cities throughout 3 law-enforcement districts into which the country was divided, with headquarters at New York, Chicago and San Francisco, respectively.

Water and Beverage Laboratory.—Research and

education in the supply, improvement and use of potable waters, the prevention of fraud in the sale of waters alleged to possess specific properties and technological progress in the soft drink industry which consumes annually about 100,000 tons of cane sugar, are special functions of the laboratory which are notable in economic value.

Microchemical Laboratory.—This laboratory is concerned with the detection of such adulterations of foods and feeds as requires the use of the microscope. In many cases chemical and bacteriological analyses fail and only the microscope is capable of giving the desired information. This is especially true for such finely ground foods as cocoa, ground spices, and cattle feeds, as well as tomato and fruit products made from decomposed stock. Without the work of this laboratory the control of such products under the food and drugs act would not be possible.

Microbiological Laboratory.—The growth of the fermentation industries which are large consumers of agricultural products and the fact that fermentation and spoilage are important factors in the waste and deterioration of these products, as well as those of the sea, give to this laboratory, the like of which did not exist in this country prior to 1913, a unique preeminence.

Cattle Food and Grain Investigation Laboratory.—This laboratory deals mainly with the control of adulteration and misbranding of feeding stuffs. It has studied the milling of rice and the crushing of cotton seed, copra, and peanuts. With a view to their utilization as feed, certain waste products, such as olive pomace, almond hulls, fruit and vegetable cannery waste, mesquite beans, and various waste seeds, have been investigated.

Pharmacognosy Laboratory. This laboratory was established in 1914 for the purpose of supervising the control over crude drugs exercised by the field force under the food and drugs act and for the conduct of such pharmacognosy investigations as are required for the efficient enforcement of the law or are designed to prevent waste or improve the utilization of crude drug products. It has encouraged the introduction of new crude drugs or of new sources for well-known drugs whenever this seemed useful.

Pharmacological Laboratory. This laboratory conducts investigations to determine whether substances that have been added to or that contaminate foods may be deleterious to health and considers also the potency of drugs.

Carbohydrate Laboratory. The work of this laboratory since 1913 may be divided into four categories: The determination of the physical and chemical properties of the sugars and their derivatives; the improvements of the methods of preparing the rare sugars; the study of methods for the analysis of sugar-containing products; and work on improving methods of manufacturing sirups, sugar and carbohydrate-containing products. The results of its work have been of inestimable value to the various industries based upon the utilization of carbohydrates and their by-products.

Oil, Fat and Wax Laboratory. In addition to investigations in the improvement of methods of analysis and of manufacturing procedure in the oil and fat industries, it has been instrumental in the establishment of a virgin peanut oil industry and in the promulgation of accurate knowledge of the composition of fats and oils of great industrial importance.

Citrus By-Products Laboratory. This laboratory

was established in Los Angeles, Calif., in 1914 to devise methods for the utilization of cull oranges and lemons and has been an important factor in the establishment of the manufacture of citric acid, lemon oil, orange oil, orange vinegar, marmalade, and candied peel in California and has done work looking to the same end in Florida. It has become the consulting chemical branch of the Department of Agriculture for much of the research that is going on in California.

Food Research Laboratory. Originally concerned with developing standards for judging food products subject to the food and drugs act, this laboratory grew into important constructive service to the poultry and egg-handling industries and to the handling, transportation and utilization of sea foods, which latter aspect of its activities represents almost the first fundamental scientific work in the American fish handling industry.

In the absence of appropriation by Congress permitting the continuance of its work after July 1, 1921, the Bureau of Chemistry was compelled to close the laboratory and to disband the staff.

Dehydration Laboratory. This laboratory is an expression of the Bureau's utilization program and is concerned with the preservation of fruits and vegetables by drying. It gives every promise of playing an important role in the country's food-preserving industry. In addition to inculcating correct manufacturing procedures the laboratory has engaged in educational work to prepare a market for products intrinsically excellent but with which the public is not familiar.

Protein Investigation Laboratory. This laboratory investigates the nutrient deficiencies of protein foods to establish that balance of the ratio whereby normal growth may best be promoted.

Phytochemical Laboratory. The phytochemical laboratory, established in 1916, has been ascertaining the nature of the chemical substances which impart to some of the edible fruits their peculiar aroma, of which until recent times practically nothing was known. In the absence of such information many of the forms of adulteration of natural fruit juices and artificial flavoring materials can not be controlled. A "synthetic apple oil," containing only such substances as are present in the apple, has been produced, which may find use for flavoring purposes.

Leather and Paper Laboratory. This laboratory is concerned with those agricultural products which are utilized by the leather, paper, and naval stores industries, and also investigates the waterproofing, mildew-proofing, and fireproofing of fabrics for farm and other uses and the utilization of wool-scouring wastes.

The industrial research of this laboratory has been an important factor in the conservation of our natural resources in the fields covered by it, in the improvement of manufacturing procedure, in the utilization of by-products and the reduction of contamination of public waters.

Insecticide and Fungicide Laboratory. The work of this laboratory comprises: The examination of insecticides, fungicides and disinfectants for various governmental departments; research in their production, properties and uses; the development of new materials and the establishment of appropriate standards and methods of analysis.

Color Investigation Laboratory. In the work of the color investigation laboratory the emphasis has been placed upon the study of the laws that govern the chemical reactions employed in the dye industry and the determination of the chemical and physical properties

of the substance of importance in dye manufacturing. For such studies the factory chemist rarely has leisure or opportunity, yet such knowledge is the foundation of the industry. Research in manufacturing procedure and in the utilization of by-products have been undertaken with notable results.

Office of Development Work.—The prevention of explosions of carbonaceous dusts, particularly as they may occur in the handling of agricultural products, with frequent fatalities and usually great economic loss, has become an important subject of investigation with this office. Its primary function, however, is as already set forth, the introduction into practical use of the scientific discoveries of the staff of the Bureau of Chemistry.

New Jersey Chemical Society

Dr. Edgar Fahs Smith, president, American Chemical Society, whose portrait sketched by Albert Rosenthal appears on the first cover of this number of *CHEMICAL AGE*, addressed the New Jersey Chemical Society at its regular monthly meeting on December 12th at Newark, N. J., his subject being "A Glimpse at the Early Organic Chemistry of the United States."

Dr. Smith's address on the beginnings of organic chemistry in America and of the place of Robert Hare as one of the fathers of American chemistry had a greater import than the interest that attaches to his presentation of an important aspect of early chemical history in this country. His presence indicated his interest in the growth and work of the New Jersey Chemical Society and of his goodwill for and encouragement of a movement that can be not only helpful to chemists but worthy of co-operation of existing organizations in the development of a professional organization of chemists.

Dr. Smith quoted from a textbook of chemistry of 1821, displayed on a screen views, of the primitive chemical apparatus of that day and showed that the term "organic" remained to be evolved twenty years later from the earlier concept of "animal and vegetable." He indicated how chloroform is a distinctively American product and one of the earliest triumphs of organic chemical synthesis in this country.

Eugene Merz, of Heller & Merz, Newark, N. J., spoke on the origin, history and procedure of manufacture of ultra-marine, illustrating his remarks with samples of raw materials and of the finished product. Ultra-marine is an example of inorganic synthesis of a natural product produced artificially first by accident in 1814 by Tessaert at St. Gobain, France. Natural ultra-marine which is the powdered mineral "lapis lazuli," is chemically the same as the artificial product prepared by heating at the requisite temperature in a reverberatory furnace the finely powdered raw material contained in earthen crucibles. These raw materials comprise china clay, soda ash, silica, sulphur, and a reducing agent usually rosin or a variety of pitch. The world production now is estimated at 35 million pounds with a market valuation of about 20 cents per pound. In the early history of this pigment, as obtained from natural sources, it was worth its weight in gold.

The meeting was well-attended and many new members were enrolled.

Dr. Wenzel Leinert, of the Leinert Engineering Co., New York, manufacturers of automatic gravity scales, left in December for a business trip through England, France, Germany and other parts of the continent, that will keep him abroad for several months.

Personal Items

Leslie R. Olsen, formerly in charge of baking, Seattle Baking Co., Seattle, Wash., is now chief chemist, International Milling Co., New Prague, Minn.

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T. A. Patterson, formerly with the Niagara Alkali Co., Niagara Falls, N. Y., is now technical director, Belle Alkali Co., Belle, W. Va.

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Herman A. Metz, president, H. A. Metz & Co., Inc., New York City, has been appointed a member of the New York city charter revision committee.

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W. H. Fieldhouse, formerly vice-president of the Ciba Company, Inc., New York City, is now sales manager for F. E. Atteaux & Co., Boston, Mass.

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Dr. Colin G. Fink, secretary, American Electro-Chemical Society, is now engaged in consulting practice at 101 Park Avenue, New York.

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J. E. Dodge, formerly with the Barrett Company, is now vice-president in charge of manufacture of the Protexol Corporation, Kenilworth, N. J.

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Ralph Dorland, Dow Chemical Company, is chairman of the New York section of the Salesmen's Association of the American Chemical Industry.

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Edward A. Dieterle, formerly with the Koppers Co., Pittsburgh, Pa., is now chief chemist, Chicago By-Product Coke Co., whose plant began operations October 20.

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Robert H. McCready, president McCready Publishing Co., publisher of CHEMICAL AGE, has returned from a two months' trip throughout France and Germany, devoted to a study of industrial conditions.

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Don Stevens, formerly with The Goodyear Tire & Rubber Co., Akron, Ohio, has accepted the managership of the Okonite Co., Passaic, New Jersey, manufacturer of insulated cable.

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Dr. H. E. Haggemacher, formerly engaged in general research with Collins & Roesell, Inc., industrial engineers, New York City, is now physical research chemist, The Gressell Chemical Co., Cleveland, Ohio.

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Mercer Reynolds, Chattanooga, Tenn., has organized the Southern Cotton & Paper Co., which will erect at that place a plant for the manufacture of paper from cotton linters.

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Dr. L. I. Shaw, assistant chief chemist of the Bureau of Mines, has been transferred to the Columbus, Ohio, Ceramic Experiment Station of the Bureau, to direct newly organized research in refractory products.

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Dr. Eugene C. Sullivan, vice-president and director of laboratories, Corning Glass Works, Corning, N. Y., has been made general manager in charge of manufacture in all the plants of the organization.

* * *

J. E. Walters, F. W. Schroeder, and Frank Porter, chemists at the helium plant of the Bureau of Mines at Petrolia, Texas, have been transferred to the new cryogenic laboratory of the bureau in Washington.

Dr. F. M. Beegle, chief chemist, The Glidden Co., Cleveland, Ohio, has returned from a several weeks' visit to Holland and France, where he studied European methods in varnish and enamel manufacture.

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Dr. Walter F. Rittman, formerly of the Bureau of Mines and later engaged in consulting practice at Pittsburgh, Pa., has been appointed head of the department of commercial engineering, Carnegie Institute of Technology.

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Louis J. Trostel has been transferred from the Pittsburgh station, Bureau of Mines, to the Bureau of Chemistry, Department of Agriculture, where as assistant chemical engineer he will be engaged on problems relating to explosions of carbonaceous dusts.

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Earle E. Richardson, instructor in analytical chemistry and physics for the past four years at the Massachusetts Institute of Technology, has been appointed research physicist under L. A. Jones at the research laboratories of the Eastman Kodak Co., Rochester, N. Y.

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In the administrative reorganization of the Du Pont Co., with the formation of five industrial departments, the following men have been appointed sales directors: L. P. Mahony, explosives department; M. R. Poucher, dyestuffs department; J. A. Burckel, pyralin department; S. B. Woodbridge, paint department, and Charles L. Petze, general director of sales, cellulose products department.

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Maurice C. Walsh, Ch.E., 1921, Columbia University, is now engaged in industrial research at Mellon Institute in connection with the newer developments which are extending the uses of the fibre container for packing cases. Mr. Walsh succeeds J. D. Malcolmson as the incumbent of the Containers' Club industrial fellowship, who will be associated with the Robert Gair Co., 350 Madison avenue, New York.

* * *

Henry C. Wallace, Secretary, Department of Agriculture, has appointed Dr. E. D. Ball, the new director of scientific work, as the representative of the department on the Research Information Service of the National Research Council to take the place of Dr. Carl L. Alsberg, resigned. The secretary also has named Dr. Frederick B. Power, for many years the director of the Wellcome Research Laboratory at London, now in charge of the phyto-chemical laboratory of the Bureau of Chemistry, as a representative of the bureau in the Division of Federal Relations in place of Dr. Alsberg.

* * *

Dr. Ernest Fox Nichols, inaugurated in June, 1921, as president of the Massachusetts Institute of Technology, under the advice of physicians after prolonged indisposition, has been compelled to relinquish this important post. Dr. Elihu Thompson, chief consulting engineer, General Electric Co., has reassumed the duties of acting president pending the selection of a successor to Dr. Nichols. Educational administration will continue in the hands of a committee comprising Dr. H. P. Talbot, head of department of chemistry and acting dean; Prof. Edward F. Miller, head of mechanical engineering and chairman of the faculty, and Prof. Edwin W. Wilson, head, department of physics.

Industrial Notes

The Grasselli Chemical Co., Cleveland, Ohio, has awarded contract for the construction of a 1-story 80x250 addition to its Long Island City, New York, plant.

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The Abbott Laboratories, Chicago, Ill., have under way the construction of a new plant estimated to cost \$450,000 at 14th and State streets, the main building of which will be a four-story and basement structure.

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The Crystal Chemical Corp., Summitville, Ind., manufacturers of silicate of soda, has begun operations in its new plant. P. W. Drackett & Sons Co., Cincinnati, Ohio, is sole distributor.

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The Van Camp Packing Co., Louisville, Ky., will build a plant for the manufacture of compound lard, an added line to its general food products business. Frederick Erhart, Louisville, Ky., is architect.

* * *

It is reported that E. I. du Pont de Nemours & Co. has increased the working force at its dye manufacturing plant at Deepwater, N. J., by about 1,000 operatives, bringing the total employees to about 2,500. Further increase is expected at an early date.

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The Bishopric Mfg. Co., Cincinnati, Ohio, is erecting a sodium sulphate plant at Stink Lake, Saskatchewan. The plant is estimated to cost \$100,000, and is planned to produce fifty tons of sodium sulphate daily for Kraft pulp manufacture.

* * *

The Dallas, Texas, plant of the Southern States Chemical Company has been purchased by the recently organized Superior Chemical Products Company. The plant will be used for the manufacture of fire extinguishing chemicals and kindred specialties.

* * *

The Solvay Process Co., Syracuse, N. Y., is enlarging its limestone quarrying operations by increasing its holdings in the region of Chaumont, N. Y., where it already owns extensive areas of land of limestone formation and adaptable for quarrying.

* * *

Winchester Dye Co., Ltd., Toronto, Can., capital \$100,000, affiliated with the Gunnash Chemical Works, Newark, N. J., has been organized to manufacture intermediates and dyes. Operation in the former plant of the Staynon Rubber Co., New Toronto, Can., will begin February 1.

* * *

The suit of Edgar Levinstein against E. I. du Pont de Nemours & Co., alleging breach of contract for supplying dyestuffs to the plaintiff, which has been pending for some time in the United States District Court at Boston, has been withdrawn and the matters of difference between Levinstein and the Du Pont Co. have been amicably adjusted and the suit dismissed.

* * *

The Dosch Chemical Co., Louisville, Ky., capitalization \$2,500,000, has acquired the property of the Bernheiser Distilling Co., of that city, and will adapt the plant for insecticide manufacturing purposes with a capacity of 20,000,000 pounds of low-grade tobacco. Two hundred and fifty thousand dollars will be spent for new equipment and the present force of 75 men will be increased under full operation after January 1st.

The Carbo-Oxygen Co., Pittsburgh, Pa., is building new works at Buffalo to manufacture commercial oxygen and hydrogen and will enlarge its plants at Bayonne, N. J., Coraopolis, Pa., Cleveland and Columbus, Ohio, establishing a complete oxygen works at each location. To carry out the project, the company has arranged for a preferred stock issue of \$2,000,000. J. C. Trees is president and J. R. Rose, vice-president.

* * *

The Seydel Mfg. Co., Jersey City, N. J., and the Nitro Products Corp., Nitro, W. Va., have amalgamated under the former title with a capitalization of \$1,500,000. Herman Seydel is president of the new organization with Paul Seydel and Frank C. Pitcher, vice-presidents. J. B. Pitcher, formerly president of the Nitro Products Corp., is secretary and treasurer. Manufacturing will be confined to the Nitro plant with general offices and research laboratories at Jersey City.

* * *

The new plant of the Corn Products Refining Co. at Kansas City will be in operation about Feb. 1. Construction costs, owing to economies, will not be greatly in excess of \$4,000,000, instead of \$6,000,000 or \$7,000,000, as originally estimated. Today the company is operating around 75 per cent. Due to the failure of the potato crop in Germany, embargo on importations of starch was raised, and the Germans are still buying starch manufactured by this company. Seven of its eight European plants are operating. The Manchester, Eng., refinery is closed down.

* * *

American Bakers' Association has acquired the property of the Wahl-Henius Institute, Chicago, Ills., and will transform this former school for brewers into one for bakers, under the direction of Dr. H. F. Barnard, former commissioner of health for Indiana.

"If science was a good thing for the development of a beverage which has been eliminated by legislation," said Dr. Barnard, "it is better to serve mankind in the development of a product which is so essential to our daily living. Our scientists will strive to substitute for the chaff which is sold as bread, a product which possesses the ultimate of food value. The days of cellar bakeries and irresponsible bakers are dwindling and college men and methods are gaining recognition."

* * *

John H. Bishop, consulting chemical engineer, 101 Park avenue, New York, has bought from the executors of the estate of John C. Wiarda, the chemical manufacturing and jobbing business long conducted by J. C. Wiarda & Co. at 273 Green street, Brooklyn. Mr. Bishop formerly was in the research and development department of the General Chemical Co., and later was chief chemist, Marcus Hook plant, of the National Aniline & Chemical Co., his last connection with the company being in the New York office in sales promotion of intermediates. Associated with Mr. Bishop, as assistant in plant management, is T. B. Prickett, formerly a departmental manager at the National Aniline & Chemical Co.'s Marcus Hook plant and later engaged in sales promotion at the company's New York office.

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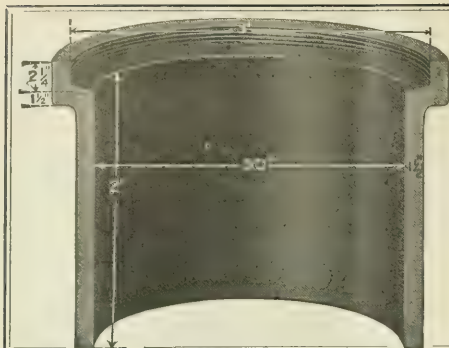


FIGURE 115
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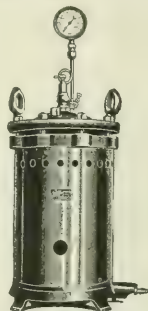
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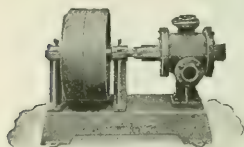
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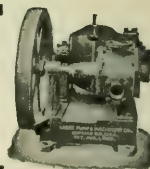
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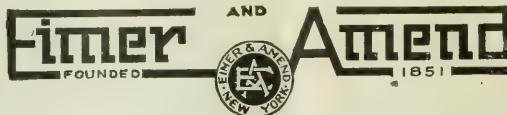
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LLOYD LAMBORN, *Editor*

McCready Publishing Company, 118 East 28th Street, New York

VOLUME 29, 1921

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